Railway Mechanical Engineer

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THE STORY WRITING CONTEST

In the November issue of this publication a story writing contest was announced which any one in the railroad field is eligible to enter.

The type of story desired must depict the romance of railroad life or deal with the problems that arise in the shops or yards, on the road, or in the office. The writer need not offer a solution of the problem he may describe—though that would be desirable—but should set forth as clearly as possible the thought he wishes to bring out; others may find the solution.

Literary finish is desirable, but the merits of a story will be judged more by the presentation of the subject and the clearness with which the action is described or the characters portrayed.

These stories may be told in as many words as are necessary to tell the tale properly, but if it is feasible they should range from 1,200 to 2,500 words.

The contest closes on April 1, 1920. In addition to paying at our regular space rates for any stories deemed suitable for publication, the writer of the story adjudged to be the best will receive a first prize of $75, the second $50 and the third $25.

Deflection of Staybolts

In an article appearing elsewhere in this issue, George L. Fowler describes a series of tests conducted to determine the action of the firebox sheets and the resulting deflection of the staybolts in locomotive boilers. The tests demonstrate the superiority of the flexible staybolt over the rigid bolt. The effect of changes of temperature on the firebox sheets, not only proved the absolute necessity of a flexible construction, but also suggests a line of study as to the effect—on the firebox sheets—of the opening of the firedoor for the purpose of firing. A careful study of the data covering these tests will show the desirability of further investigation of this subject and it is to be hoped that the work will be continued.

Failures of Welded Firebox Seams

The annual report of the chief of the Bureau of Locomotive Inspection calls attention to several serious failures which occurred in fireboxes having seams welded by autogenous processes. The examples cited bring out very clearly that while low water was directly responsible for the failures, the welded seams apparently gave way at a lower temperature than riveted seams, causing more extensive rupture with consequent greater damage, which no doubt contributed to the increased number of deaths due to boiler explosions. It will be conceded that the safety of men operating the locomotive is of prime importance and no method of construction should be used which increases the hazard due to low water. For this reason the recommendation for limitation in the use of autogenous welding in boilers must be carefully considered. Before discarding the practice, however, it would be well to give a thorough test to methods of examination of welds to determine the quality of the metal added, which have been developed during the past year to a point where they will serve as a fairly reliable indication of the strength of the seam.

If this method does not prove satisfactory it is possible that minor changes could be made in the construction of the firebox to lessen the explosive force of the escaping steam. It has been the practice on some roads to install several rows of crown stays with small heads at the front of the crown sheet. In case the sheet became overheated these stays would

offer little resistance and the sheet would bag before the water level fell any great distance. This has been found to be a satisfactory method of reducing the violence of boiler explosions and a similar type of construction used in connection with welded seams might overcome the objections mentioned in Mr. Pack's report.

The Shop Employees' Wage Agreement

The agreement covering wages and working conditions, which went into effect in October includes some remarkable provisions. No one can deny the justice of having definite rules to govern the practices in shops and these are on the whole not open for serious criticism. In the classification of the employees, however, the policy of placing the skilled and unskilled workers on the same basis has prevailed, with evident injustice to the more highly skilled men. Apparently an effort has been made to broaden the scope of the work assigned to each craft as much as possible. As a result, a tool maker and the operator of a tool grinder are placed in the same class. The valve setter and the man who removes superheater units from the front end receive the same rate of pay. It is hardly clear why the work of removing parts from cars to be dismantled should demand such special skill that carmen are required to handle it. On the whole the agreement seems to provide plenty of positions on the railroads for inferior mechanics, but little to attract the better class. The rule specifying that applicants for employment will be required to make statement only as to their ability and the addresses of relatives apparently furnishes abundant opportunity for undesirables of all kinds to enter railroad service.

The rigid application of the seniority rule, with the provision for posting bulletins concerning vacancies, removes from the foreman the right to select the men best fitted for the work. The only assurance provided is that the workman must be able to meet the minimum requirements of the position. Such abrogation of one of the very important functions of the foreman can hardly fail to have a bad effect upon the supervision. Some of the provisions of the agreement result in increasing the actual hourly rate of pay to a considerable extent. All employees required to check in and out on their own time are paid for an extra hour each week. Where three shifts are employed, 20 minutes are allowed for lunch without a corresponding deduction from the wages. In case a machinist worked an eight-hour shift for seven days a week, these two rules would increase the hourly rate of pay from 72 cents to 76.4 cents, or over six per cent. With the large number of employees working in roundhouses this increase in the pay-roll is quite appreciable.

Should the Front Waste Plug Be Retained

For some time a number of railroads have had in use a method of packing journal boxes without the use of the plug which is ordinarily placed at the end of the journal. Those who have been active in securing the adoption of this method of packing journal boxes claim that by its use a saving of 15 per cent in oil and waste is effected and better lubrication is obtained. The practice has not been in sufficiently general use to determine conclusively whether these claims are borne out in practice.

It would no doubt be feasible to operate cars with very small pads of waste under the journal if the cars were given attention at short and regular intervals. The question arises whether the elimination of the front waste plug necessitates more frequent inspection and setting up of the packing. Those who still adhere to the use of the front waste plug claim that it serves as an extra reservoir of oil, assists in keeping the dirt out and prevents the waste from working forward when the car is in motion. Considerable trouble has been experienced on cars packed without the front plug, due to the packing working forward, causing the inner end of the journal to become dry and heat. Some attempt has been made to standardize the method of packing without the front plug. If the operating results are as satisfactory as those secured by the former method this would no doubt be desirable. Delays due to hot boxes are so serious and costly that this method should be subjected to long and thorough trial before it is adopted as a standard practice.

Watch the Brake Shoes

The braking of modern railroad trains is so important a subject and the cost of the brake shoes such a large item in railroad expenditures that the use of brake shoes must be given very careful attention to keep the costs within reasonable limits. As the most efficient brake rigging ever made can function only through the brake shoe, which comes in contact with the wheel, it is obvious that the composition and use of the brake shoe is a vital matter. With the high speeds and heavy equipment in use at the present time the brake shoe not only must possess high frictional qualities, but must be of such texture and be reinforced in such a manner that it will also be durable and safe. By long experiment these desirable qualities have been attained in a very high degree.

The cost of the type of brake shoe required for the average service is considerably in excess of that of an ordinary plain casting and it is incumbent on those men who apply them to get the greatest possible wear from each brake shoe before it is sent to the scrap pile. An inspection of the brake shoe scrap in almost any railroad yard will reveal great numbers of brake shoes that have been removed and scrapped because of taper wear, with only a small part of the casting worn off in service. This is a condition that can in most cases be remedied by giving closer attention to the wear of the shoes, removing the shoe from the brakehead when the tapered wear becomes apparent, and applying it to another wheel with the position of the shoe reversed. This is particularly true of driving brake shoes, and as the average weight of the type of driver shoe most commonly used is over 50 lb., it is possible to effect a great saving in locomotive brake shoe cost by reversing the shoes before the tapered wear has progressed too far to permit of doing this. Another means of brake shoe conservation is to remove partly worn shoes from the most severe service, where a brake shoe failure might prove disastrous and utilize such shoes on lighter equipment.

These and other means of brake shoe economy are very well known to most railroad men, but unfortunately the brake shoe is too often regarded as a secondary matter and is not given the attention that its importance merits. That it pays to give close attention to brake shoe wear was proved on at least one railroad, where in the course of a year the brake shoe costs were reduced many thousands of dollars without any appreciable increase in the labor cost of application. This result was achieved, despite the fact that there was a very considerable increase in both the number and size of the rolling stock.

The foremen at roundhouses and terminals should be on the alert and by close attention to the application and removal of brake shoes should keep the consumption at the lowest possible figure.

Car Department Apprentices

The provisions for apprentices in the car department are not sufficiently attractive as compared with the rules for apprenticeship in the other crafts to make car work attractive to young men, and it is doubtful whether the railroads will find it possible to recruit the necessary number of car department apprentices under these rules.

The rate of pay in the car department is lower, yet the length of apprenticeship is the same as in the other trades. Even if a young man for some reason preferred to enter the car department it would be to his advantage to enter as a helper apprentice, where he would receive 49 cents an hour instead of the 29-cent rate paid the regular apprentices. The helper apprentice, to be sure, is required to spend five years before he is rated as a mechanic, but the compensation is so much greater that it would more than offset the disadvantage of the longer apprenticeship. Those who framed the agreement apparently realized that there would be difficulty in securing apprentices in the car department and a special provision has been made for promoting helpers if necessary. The need of apprentices in the car department is becoming more generally recognized and if the present schedule operates as is anticipated it is to be hoped that service in the car department will be made more attractive for those who desire to enter apprenticeship courses.

Draft Gear for High Capacity Cars

The performance of freight cars of unusually high capacity has proved so satisfactory from an operating standpoint on the roads where they have been tried that this type is finding much favor and it is probable that cars with capacities of approximately 100 tons will be built in considerable numbers when the railroads again enter the market for equipment. With any such radical increase in the size of the unit there are important points in design to be worked out and the question naturally arises whether some of the standards developed for smaller cars will serve satisfactorily on cars of such high capacity. In some cases it is possible to increase the number of parts used, thereby keeping down the stresses to which each unit is subjected. Where the maximum journal capacity of eight pairs of wheels is not sufficient to carry the load six-wheel trucks have been used and other difficulties can be met in a similar manner.

One of the important appliances used on freight cars which is limited in size because of standard dimensions is the draft gear. With heavier cars greater draft gear capacity will be needed and it is doubtful whether the necessary capacity to absorb shocks can be obtained within the present narrow space restrictions. No satisfactory tandem arrangement of friction draft gear has been devised, and if it could be developed it is doubtful whether its use would be advisable, due to the difficulty of inspection. Under certain circumstances one gear might be placed above the other, but this would raise the floor level and therefore could be applied only to certain types of cars.

It would seem that the first change that should be made in adapting draft gears for higher capacity cars would be to increase the travel to approximately four inches. This extra travel should not be objectionable because the large size of the cars reduces the number of units in the train. This would offer an opportunity for increasing the capacity of the gear approximately 75 per cent. Even with the increased travel the large amount of work to be absorbed might cause unduly rapid wear of the gear. If this proves to be the case it would be advisable to increase the space between the center sills and possibly also the distance between the front and rear coupler stops.

An incidental advantage to be gained by wider spacing between the center sills would be greater angular movement of the couplers. The present spacing allows very little side play for the coupler shank and in rounding curves the coupler often bears very heavily against the sides of the striking casting. In fact, the stresses set up are sometimes sufficient to bend the coupler shank. In designing long cars provision should be made for greater angular movement of the coupler. This can only be provided by an increase in the distance between the center sills.

Machine Shop Limits Output

That the output of practically every locomotive repair shop is limited by its machine shop capacity no one familiar with the conditions will be likely to deny. Should there be a doubt on this point it can be set at rest by even a casual inspection of the average railway machine shop. In most shops the floor is so congested with motion work and running gear parts in various stages of repair that it is difficult to pass from one machine to another. The link job, in particular, is usually behind, with link hangers, trunnion blades, radius bars and combination levers everywhere in evidence and all waiting for machine work. Perhaps the rod job has been "caught up" but the unexpected receipt of four or five sets of rods from the roundhouse, (marked "rush") places this work hopelessly in arrears again. The wheel and driving box job is another bugbear and many a locomotive has been delayed in the shop one or more days due to late wheeling.

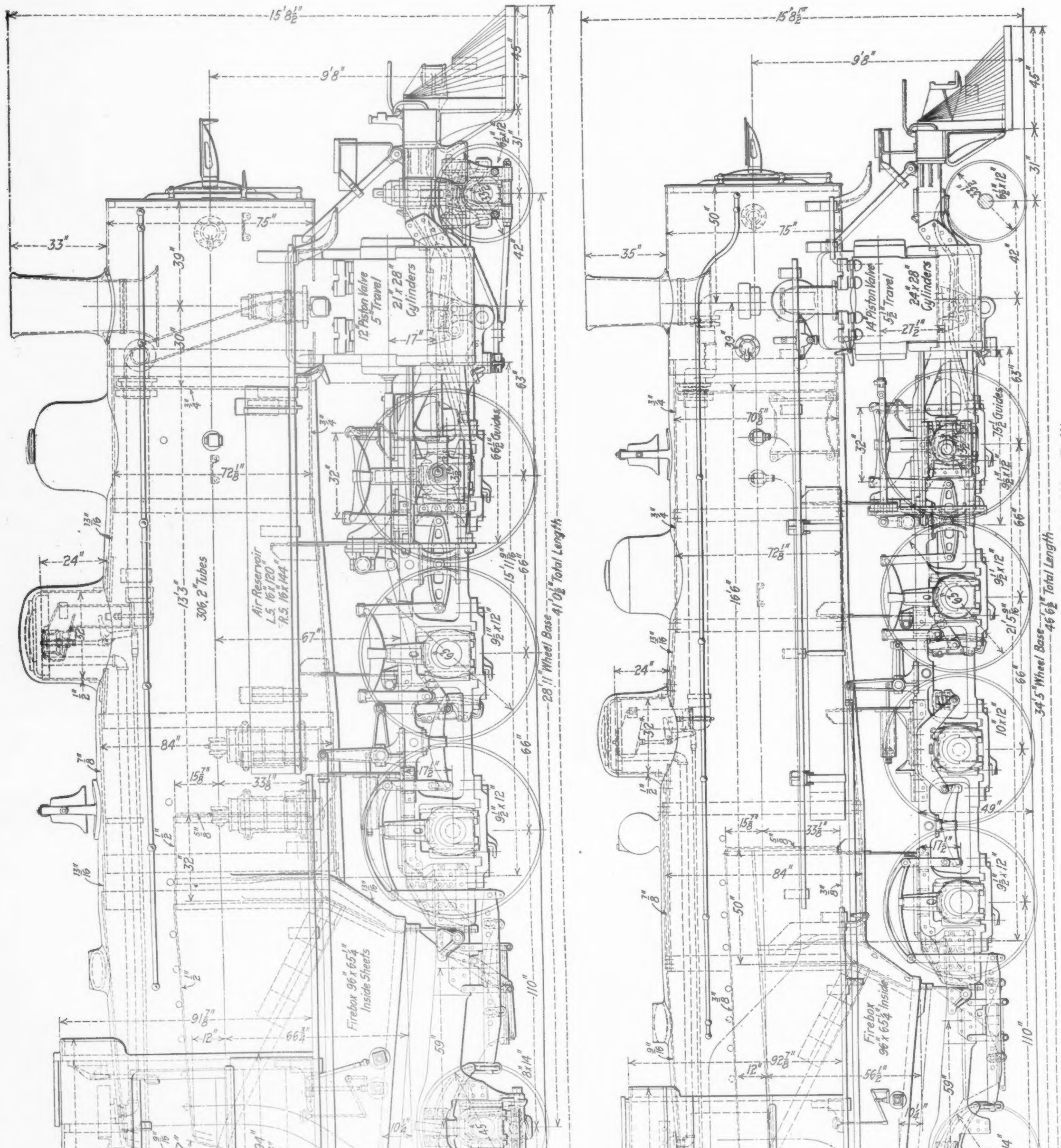
With an increase of 57 per cent in freight traffic alone in the past four and one-half years, it is evident that the new business cannot be handled unless locomotives are kept on the road. They cannot be held in repair shops while repairs are made with the present inadequate machine shop equipment and facilities, consequently the number held in roundhouses for heavy work is rapidly increasing. It is hoped that Congress in turning the roads back to their owners will make arrangements that will permit the roads to finance improvements and bring all their equipment up to the standard necessary to take care of the increased business.

Not only is it essential to provide increased machine tool equipment; machine foremen can help out the situation by keeping posted on improved methods and using what machines they have to the best advantage. Are they doing this? It is generally conceded that driving box shoes and wedges should be machined on a horizontal miller, but many shops are still planing them. Slightly worn guides should be trued up by grinding, but here again the planer is used, which requires more time for a poorer job. Such modern machines as are already installed should be used to their utmost capacity and in addition new machinery must be purchased in the near future or the country's industries will be seriously handicapped by the lack of motive power.

NEW BOOKS

Applied Science for Wood-Workers. By W. H. Dooley, 446 pages, 5¼ in. by 7½ in., illustrated, bound in cloth. Published by the Ronald Press, New York.

The purpose of this book is to provide an elementary course in applied science for the woodworking trades to bridge over the gap between the abstract knowledge of the principles of science acquired by the average high school student and the practical application of these principles in industrial life. The book is a compilation of considerable generally known data, supplemented by knowledge gained through practical experience. Of particular interest to woodworkers are the chapters on trees, lumber, defects of wood. In addition the book treats in a clear and concise manner of woodworking tools and their uses, modern foundry methods, heating, ventilating, paints and varnishes, electricity and other subjects, which although not directly related to the woodwarking trades, are of value to anyone engaged in mechanical pursuits. A series of questions and problems at the end of each chapter serves to bring out the salient points of each subject and to test the student's power of concrete application of the principles set forth in the text.



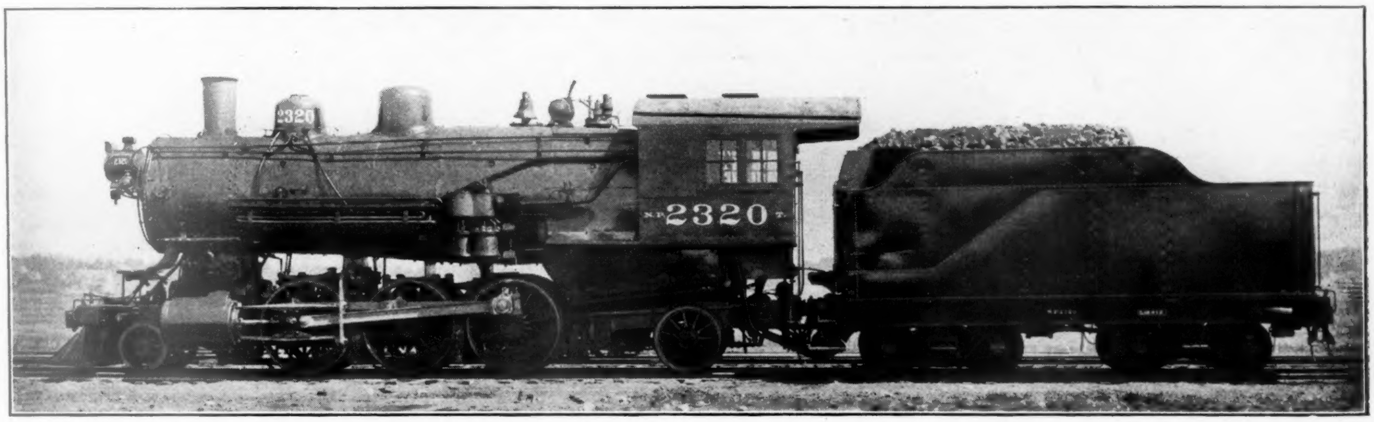
Elevation of the Mikado Type and the Prairie Type from Which It Was Built

Changing Prairie Type to Mikado

Redesigned Boiler Gives Higher Efficiency and Ample Steaming Capacity for Larger Cylinders

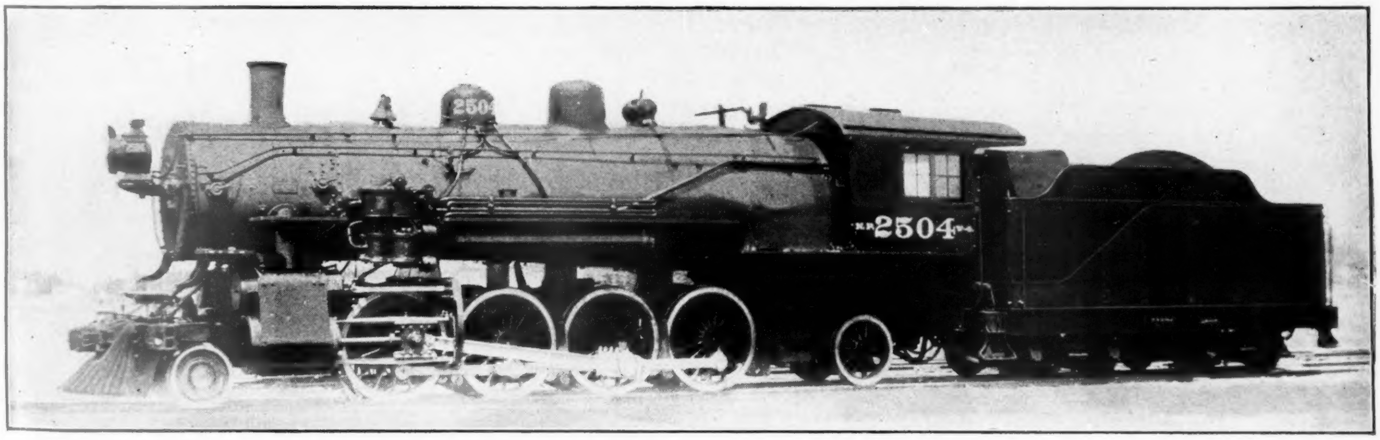
Among the equipment owned by the Northern Pacific there is a considerable number of locomotives of the Prairie type which were built about the year 1906. As these engines used saturated steam and had a rated tractive effort of 33,300 lb., they were not economical units for through freight service as regards either fuel or train loads. With a view to improving the performance of the engines and prolonging their period of usefulness, the operating department considered the advisability of converting them to the Mikado type. Plans were accordingly made in 1914, and six locomotives were changed at the Brainerd, Minn., shop in 1918 and 1919.

The Prairie type locomotives had a total weight of 204,500 lb. and a tractive effort of 33,300 lb., while the Mikados weighed 249,000 lb. with 40,300 lb. tractive effort. In working out the alterations to be made, the original parts of the machinery and running gear were retained as far as possible. The addition of a fourth pair of driving wheels made new main frames necessary. The increased tractive effort desired called for larger cylinders and, to take care of the greater stresses, cast steel frames of larger section were designed. The engines as originally built had a short rigid wheel base, and the distance from the transverse center of the cylinder to the front axle was unusually short for locomotives of the Prairie type. It was, therefore, possible to keep the same dimension from the cylinder to the front driving wheel and also to retain the uniform spacing of 66 in. between the centers of the drivers. Since the weight per driving axle remained practically unchanged, no greater stresses were introduced in the equalizing system and the same springs, equalizers and hangers were used on the Mikado engine with the additional parts required to take care of the extra wheel. On both engines the equalizing system is divided between the second and third pair of drivers.



Northern Pacific Prairie Type Locomotive, Class T

The cylinders on the Prairie type, or class T engine, were 21 in. by 28 in., but on the Mikado, or class W-4, they were enlarged to 24 in. by 28 in. with outside steam pipes. In order to provide for the greater piston thrust, the main axle was made 10 in. in diameter, but on the other wheels the original 9½ in. axle was retained. The piston rod was made 3½ in. longer and the main rod was shortened the same amount. As the position of the center line of the valve chamber was changed, a new rocker was made for the valve gear. The valve travel was also increased from 5 in. to 5½ in.



Mikado Type, Class W-4, Rebuilt from Class T

In changing the boiler the original barrel was retained, and a new front course and an enlarged smoke box were added. The increase in the length of the frame, as before mentioned, was 66 in. The space required for the superheater header made it necessary to set the front tube sheet

9 in. farther back from the center line of the stack. The remaining 57 in. was utilized by adding 39 in. to the length of the tubes, making them 16 ft. 6 in. long, and by increasing the length of the combustion chamber from 32 in. to 50 in. The brick arch was retained in its original position and no other change was made in the firebox. A superheater with 28 elements was added which, with the other changes, increased the equivalent heating surface from 2,359 sq. ft. to 3,186 sq. ft.

A comparison of the ratios of the class T and class W-4 is of particular interest in view of the restrictions placed on the design of the Mikado due to the necessity of conforming to many of the main dimensions of the Prairie type. The tractive effort was increased not in the same ratio as the weight on drivers but in the same ratio as the total weight, or about 21 per cent. The extension of the boiler barrel in a saturated engine would have increased the heating surface about 20 per cent, but with the addition of the superheater the equivalent heating surface was raised 35 per cent. The benefit of this change is shown by the decrease of the total weight per square foot of heating surface from 86.7 to 78.2 and the increase in the square feet of heating surface per cubic foot of cylinder volume from 210.6 to 217.9 square feet.

Excellent operating results have been secured with the new class W-4 engine. They have been placed in service on the division between Glendive and Billings, Montana, where the heaviest ruling grade westbound is 26 ft. per mile. In this direction the rating of the Prairie type is 1,600 tons, while the rating for the Mikado is 2,600 tons, an increase of 62 per cent. On the eastbound movement the length of the trains is controlled by the passing siding, and the ratings for the two types are as follows: From Billings to Forsyth, class T, 2,900 tons; class W-4, 3,400 tons; from Forsyth to Glendive, class T, 2,800 tons; class W-4, 3,300 tons.

The improvements in the smoke box were designed to overcome the trouble of throwing sparks. With the class T engines this has been very annoying in the past, particularly when used in the district where semi-bituminous coal is burned.

The converted engines ride much easier than the Prairie type and, because of the better load distribution, are much easier on the track.

An additional advantage secured by the conversion to the Mikado type is uniformity of train loads on several divisions. The heavier Mikados in use on the Northern Pacific have tractive efforts of 46,000 lb. and 57,100 lb. and, in conjunction with the class T and class W-4, provide motive power units adapted for hauling approximately equal tonnage on lines where the grades vary widely, thus facilitating through movement without breaking up trains at division points.

For the purpose of comparison the principal dimensions, weights and ratios for the two types of locomotives are as follows:

	Class T 6-3-2	Class W-4 2-8-2
General Data		
Gage	4 ft. 8½ in.	4 ft. 8½ in.
Service	Freight	Freight
Fuel	Bit. coal	Bit. coal
Tractive effort	33,300 lb.	40,300 lb.
Weight in working order	204,500 lb.	249,000 lb.
Weight on drivers	153,500 lb.	204,000 lb.
Weight on leading truck	20,500 lb.	19,600 lb.
Weight on trailing truck	30,500 lb.	25,400 lb.
Weight of engine and tender in working order	353,000 lb.	397,500 lb.
Wheel base, driving	11 ft. 0 in.	16 ft. 6 in.
Wheel base, total	28 ft. 11 in.	34 ft. 5 in.
Wheel base, engine and tender	57 ft. 3½ in.	62 ft. 9½ in.
Ratios		
Weight on drivers ÷ tractive effort	4.61	5.06
Total weight ÷ tractive effort	6.14	6.18
Tractive effort × diam. drivers ÷ equivalent heating surface*	889.3	796.9
Equivalent heating surface* ÷ grate area	54.2	73.2
Firebox heating surface ÷ equivalent heating surface,* per cent	10.0	8.15
Weight on drivers ÷ equivalent heating surface*	65.1	64.0
Total weight ÷ equivalent heating surface*	86.7	78.2
Volume both cylinders	11.20 cu. ft.	14.62 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	210.6	217.9
Grate area ÷ vol. cylinders	3.88	2.98
Cylinders		
Kind	Simple	Simple
Diameter and stroke	21 in. by 28 in.	24 in. by 28 in.
Valves		
Kind	Piston	Piston
Diameter	12 in.	14 in.
Greatest travel	5 in.	5½ in.
Outside lap	1 in.	1 in.
Inside clearance	0 in.	0 in.
Lead in full gear	1/32 in. neg.	1/32 in.
Wheels		
Driving, diameter over tires	63 in.	63 in.
Driving, thickness of tires	3½ in.	3½ in.
Driving journals, main, diameter and length	9½ in. by 12 in.	10 in. by 12 in.
Driving journals, others, diameter and length	9½ in. by 12 in.	9½ in. by 12 in.
Engine truck wheels, diameter	33½ in.	33½ in.
Engine truck journals	6½ in. by 12 in.	6½ in. by 12 in.
Trailing truck wheels, diameter	45 in.	45 in.
Trailing truck journals	8 in. by 14 in.	8 in. by 12 in.
Boiler		
Style	Ext. Wagon Top.	Ext. Wag. top.
Working pressure	200 lb. per sq. in.	185 lb. per sq. in.
Outside diameter of first ring	72⅛ in.	70⅝ in.
Firebox, length and width	96 in. by 65¼ in.	96 in. by 65¼ in.
Firebox, plates, thickness	Door, crown and sides ⅜ in.; tubes ⅝ in.	Door, crown and sides ⅜ in. tubes ⅝ in.
Firebox, water space	Front 4½ in., back and sides 4 in.	4½ in. and 4 in.
Tubes, number and outside diameter	306-2 in.	173-2 in.
Flues, number and outside diameter		28-5⅜ in.
Tubes and flues, length	13 ft. 3 in.	16 ft. 6 in.
Heating surface, tubes and flues	2124 sq. ft.	2138 sq. ft.
Heating surface, firebox	235 sq. ft.	259 sq. ft.
Heating surface, total	2359 sq. ft.	2399 sq. ft.
Superheater heating surface		526 sq. ft.
Equivalent heating surface*	2359 sq. ft.	3186 sq. ft.
Grate area	43.5 sq. ft.	43.5 sq. ft.
Tender		
Tank	Rectangular	Rectangular
Journals, diameter and length	5½ in. by 10 in.	5½ in. by 10 in.
Water capacity	8,000 gal.	8000 gal.
Coal capacity	12 tons	12 tons

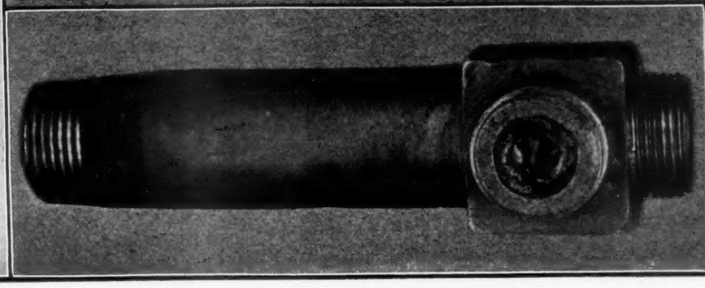
* Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

Photo Copyright by Kadel & Herbert.

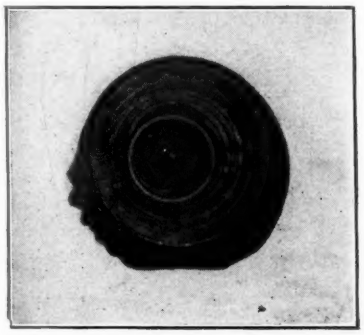
An Unusual Ferry—Kiel, Germany

I. C. C. LOCOMOTIVE INSPECTION REPORT

Disastrous Results of Low Water in Welded Fire-Boxes Blamed for Increase in Fatal Accidents



THE eighth annual report of the chief inspector of the Bureau of Locomotive Inspection, which covers the year ending June 30, 1919, has recently been published. Tables I to IV show the number of locomotives inspected and the defects found. As the amendment to the boiler inspection law, extending its scope to include the entire locomotive and tender and all appurtenances, did not become effective until September 4, 1915, the record of the



Water Glass Cock Opening Almost Closed by Scale

fiscal year ended June 30, 1916, includes accidents and casualties for only nine months and 26 days.

TABLE I—COMPARATIVE STATEMENT SHOWING LOCOMOTIVES INSPECTED AND NUMBER FOUND DEFECTIVE

	1919	1918	1917	1916
Number of locomotives inspected...	59,772	41,611	47,542	52,650
Number found defective...........	34,557	22,196	25,909	24,685
Percentage found defective........	58	53	54.5	47
Number ordered out of service.....	4,433	2,125	3,294	1,943
Total defects found................	135,300	78,277	84,883	71,527

TABLE II—NUMBER OF ACCIDENTS, NUMBER KILLED AND NUMBER INJURED

	1919	1918	1917	1916
Number of accidents..........................	565	641	616	537
Decrease from previous year......per cent	11.8	[1]4.1	([2])	...
Number killed	57	46	62	38
Decrease from previous year......per cent	[1]23.9	25.8	([2])	...
Number injured	647	756	721	599
Decrease from previous year......per cent	14.4	[1]4.8	([2])	...

TABLE III—ACCIDENTS DUE TO FAILURE OF BOILERS AND APPURTANCES ONLY

	1919	1918	1913	1912
Number of accidents..........................	341	398	820	856
Decrease 1919 over 1918...........per cent	14.3	...	...	...
Decrease 1919 from 1912...........per cent	60.2	...	...	...
Number killed	45	36	36	91
Increase 1919 over 1918...........per cent	25	...	...	...
Decrease 1919 from 1912...........per cent	50.5	...	...	...
Number injured	413	510	911	1,005
Decrease 1919 from 1918...........per cent	19	...	...	...
Decrease 1919 from 1912...........per cent	58.9	...	...	...

A summary of all accidents and casualties occurring during the fiscal year ended June 30, 1919, covering the entire locomotive and tender and all of their appurtenances, shows

[1]Increase.
[2]Percentage in decrease not shown for 1917, because of amended act not being in effect the entire year of 1916.

TABLE IV—CASUALTIES DUE TO FAILURE OF LOCOMOTIVES, TENDERS OR APPURTANCES

	Year ended June 30—							
	1919		1918		1917		1916	
	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured
Members of train crew:								
Engineers	14	194	11	245	16	230	11	205
Firemen	22	265	19	306	21	304	12	225
Brakemen	11	82	6	62	13	60	9	74
Conductors	2	16	...	21	3	14	1	6
Switchmen	1	7	2	8	1	8	...	6
Roundhouse and shop employees:								
Boilermakers	1	9	...	11	...	11	1	11
Machinists	..	5	...	11	...	8	1	11
Foremen	..	3	1	4	...	1	1	3
Inspectors	.	6	4	4	...	3	...	3
Watchmen	..	2	...	3	...	5	...	8
Boilerwashers	..	7	1	4	...	7	...	10
Hostlers	..	6	...	8	...	6	...	6
Other roundhouse and shop employees	1	11	2	19	2	19	1	21
Other employees	3	23	...	26	5	22	...	7
Non-employees	2	11	...	24	1	23	1	3
Total	57	647	46	756	62	721	38	599

Result of Explosion Caused by Low Water. Welded Seam Between Crown and Side Sheets Gave Way

a decrease of 11.8 per cent in the number of accidents, an increase of 23.9 per cent in the number killed, with a decrease of 14.4 per cent in the number injured, as compared with the year ended June 30, 1918.

A summary of all accidents and casualties, caused by the failure of the locomotive boiler and its appurtenances only, for the fiscal year ended June 30, 1912, which was the first year of the existence of the law, compared with a summary of all accidents and personal injuries which occurred during the fiscal year ended June 30, 1919, shows the substantial

decrease in the number of accidents, due to such failures, of 60.2 per cent; a decrease in the number of persons killed of 50.5 per cent, and decrease in the number injured of 58.9 per cent.

FAILURES OF AUTOGENOUS WELDS IN FIREBOXES.

It will be noted from Tables II and IV that the number of fatalities due to locomotive failures has not been reduced in proportion to the number of accidents. This fact is commented on as follows:

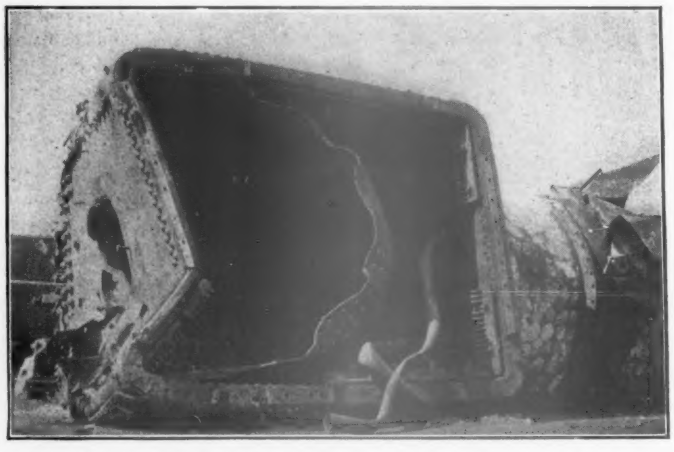
The increase in the number of persons killed during the last year, over the year previous, is, to a considerable extent, due to some very violent explosions which occurred because of fire box crown sheet failures, which serve to illustrate the prime importance of proper fire box construction, inspection and repair, together with the location, inspection and maintenance of such appliances as water glasses, gage cocks, injectors, steam gages and safety valves, upon which to a very great extent, rest the safety of locomotive boiler operation.

While some of these explosions were primarily caused by low water, it is believed that their violence and consequent results were greatly increased by failure of crown sheet seams which had been welded by the autogenous process. The failure of such seams, which have come into extensive use during the past few years, in most cases evidently caused the initial rupture and, in some cases, occurred with slight overheating.

Investigation of these accidents indicated that the failure of the welds occurred with a higher level of water in the boiler, and consequently a lower temperature in the sheet, than in other cases where the crown sheets failed and did not tear.

It will be recognized that the force of a boiler explosion depends upon the extent and suddenness of the initial rupture, together with the volume and temperature of the water in the boiler at the time of explosion. This feature is clearly brought out in the illustrations showing fireboxes which have failed in actual service.

It is true that not all autogenously welded fire box seams fail at the time of boiler explosion, but inasmuch as our records show that 80 per cent of all such welds involved have failed under such conditions, it is believed that, until



Dropped Crown Sheet Due to Low Water, Showing Failure of Welded Seam

some way has been discovered through which the quality and tenacity of a weld so made may be established in advance of its failure, fire box crown sheet seams so constructed should be avoided, where overheating and failure are liable to occur, and that autogenous welding should not be used where the strength of the structure is dependent upon the weld, nor where the strain, to which the structure is subjected, is not carried by other construction; nor in any part of a locomotive boiler wholly in tension while under working conditions.

It has been our purpose to co-operate with the United States Railroad Administration and the officials of the various carriers to the fullest extent consistent with our duties and the purpose of the law, and avoid as far as possible being compelled to order locomotives removed from service for unsafe conditions at a time when traffic might be seriously delayed. The fact that not a single formal appeal from the decision of any inspector, as provided for in section 6 of the law, has been filed during the fiscal year clearly demonstrates the wisdom and good judgment that has been exercised by them.

During the year, 198 applications were filed for an extension of time for the removal of flues, as provided for in rule 10. Investigation showed that, in 28 of these cases, the condition of the locomotives was such that no extension could properly be granted. Twenty-two were in such condition that the full extension requested could not be granted, but an extension for a shorter period within the limits of safety was allowed. Eleven extensions were granted after defects disclosed by our investigation had been repaired. Twenty-eight applications were withdrawn for various reasons, and the remaining 109 applications were granted for the full period as requested.

As provided in rule 54, there were filed 3,324 specification cards and 5,949 alteration reports. These were carefully checked in order to determine whether or not the boilers represented were so constructed as to be in safe and proper condition for service, and that the stresses given therein had been correctly calculated. The provisions of rule 2, by which all boilers are required to have a factor of safety to meet the requirement, has made necessary the strengthening of various parts of numerous boilers.

LOCOMOTIVE HEADLIGHTS

Substantial progress has been made in equipping locomotives with lights which will meet the requirements of the commission's orders of December 26, 1916, and December 17, 1917. The effective date of the commission's orders was fixed as of July 1, 1918.

Notwithstanding the strenuous oppositon offered by certain carriers to the promulgation of these requirements, these lights are meeting with the general approval of the employees who are employed where locomotives are so equipped; and the general expression is that "they are a great safety device." A number of the railroad officials, under whose jurisdiction these lights are being operated, have expressed their opinion that "they are economical and add materially to the safety of operation."

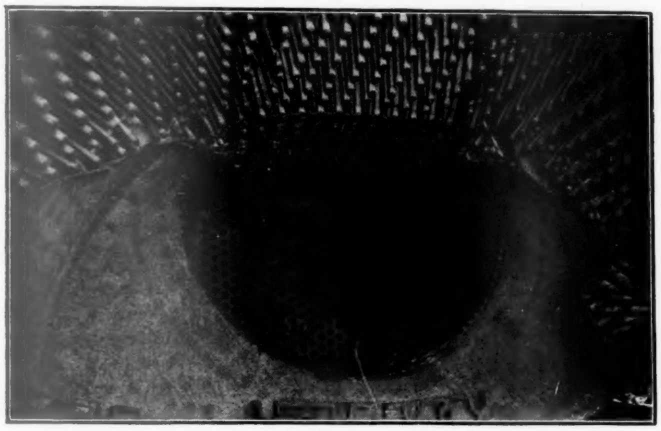
Under the order of the commission of April 7, 1919, certain modifications in the rules, which were granted in their order of September 20, 1917, because of conditions brought on by war, were abrogated, and others substituted. Experience had demonstrated that certain modifications, granted in the commission's order of September 20, 1917, could be made permanent, without adversely affecting the safety of operation; therefore, such modifications were retained in the permanent rules.

BOILER EXPLOSIONS

It is interesting to note that during the fiscal year ended June 30, 1912, there were 97 boiler explosions from all causes, resulting in the death of 81 persons and the serious injury of 209 others, while during the last year there were 67 explosions, resulting in the death of 39 persons and the serious injury of 112 others. These reductions amount to 30.9 per cent in the number of explosions, 51.8 per cent in the number killed, and 46.4 per cent in the number injured.

Attention is also directed to the fact that, since the inception of this bureau, 516 boiler explosions have occurred, resulting in the death of 277 persons and the serious injury of 889 others.

Five of these explosions, resulting in the death of 29 persons and serious injury of 50 others, were due to failure of shell sheets, caused by overpressure or defective sheets, which could have been detected and their failure avoided by proper inspection and repairs; 289, causing the death of 156 persons and the serious injury of 486 others, were due to failure of crown sheets, caused by low water, and where no contributory defects were found; 195, resulting in the death of 83 persons and the serious injury of 317 others, were due to failure of crown sheets caused by low water and where contributory defects, constituting violation of the law or rules, such as defective water glasses, gage cocks, injectors, broken stays or crown bolts, etc., were found; 22, causing the death of 4 persons and the serious injury of 31 others, were caused by failure of firebox sheets, due to defective or broken staybolts or crown stays; 5, causing the death of 5 persons and the serious injury of 5 others, were due to foaming of the water in the boiler, allowing the firebox sheets to become overheated.



Failure in Wootten Type Firebox Due to Low Water. Riveted Seam at Tube Sheet Intact, Welded Seam Failed

Investigation showed that in 19 of the explosions which occurred during the last year, due to low water, defective water glasses and connections contributed to the cause of such failures, which fact clearly demonstrates again the importance of properly locating and maintaining such parts before placing boilers in service.

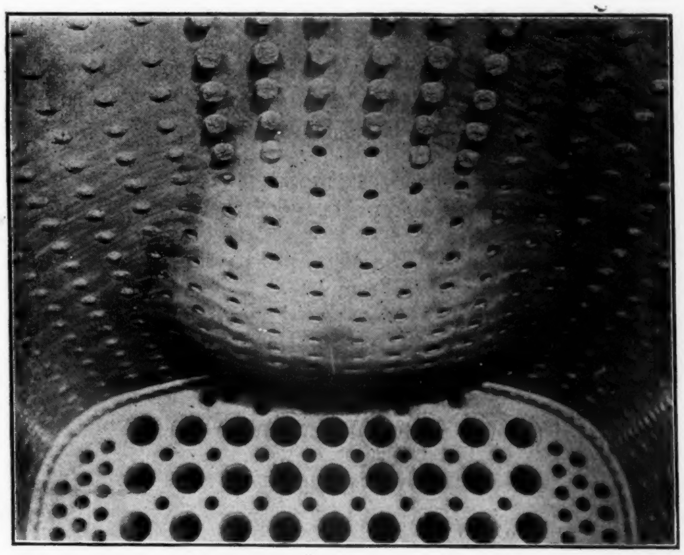
PRINCIPAL CAUSES OF ACCIDENTS

Our records show that during the past eight years, failure of squirt hose and their connections caused 976 accidents, resulting in the death of one person and the serious injury of 984 others; failure of 362 flues caused the death of three persons and the serious injury of 425 others; failure of 511 water glasses or their connections caused the death of one person and the serious injury of 515 others; failure of 148 grate-shaking appliances resulted in the death of one person and the serious injury of 147 others.

It is a physical impossibility for 50 inspectors to inspect at regular intervals and be familiar with the condition of any large percentage of 69,000 locomotives. The law places the responsibility for the general design, construction, and maintenance of all locomotives and tenders upon the carriers owning or operating them. It appears, however, that many officials and employees of the carriers, who are responsible for the inspection and repair of locomotives, have tried to evade this responsibility, and have, apparently, endeavored to transfer it to the federal inspectors, by allowing locomotives to remain in service with serious violations of the law and rules known to them, until our inspectors found them and caused the locomotives to be removed from service for needed repairs. The data shown in this report should impress the necessity of proper performance of duties upon those who are required to inspect and report defects on locomotives, as well as upon those who are responsible for the proper repair of such defects.

CHANGES RECOMMENDED

The following recommendations are made for the betterment of the service: First. That the act of February 17, 1911, be amended so as to provide for at least 50 additional inspectors. Second. That all locomotives not equipped with mechanical stokers or those using oil for fuel shall have a mechanically operated fire door, so constructed that it may be operated by pressure of the foot on a pedal, or other suitable device, located on the floor of the cab or tender at a proper distance from the fire door so that it may be conveniently operated by the person firing the locomotive. Third. That a power-reversing gear be applied to all locomotives and the air-operated power-reversing gear have a steam connection with the operating valves conveniently located in the cab, so arranged that, in case of air failure, steam may be quickly used to operate the reversing gear. Fourth. That a power grate shaker be applied to all coal-burning locomotives. Fifth. That all locomotives shall be provided with a bell, so arranged and maintained that it may be operated from the engineer's cab by hand and by power. Sixth. That cabs of all locomotives not equipped with front doors or windows of such size as to permit of easy exit shall have a suitable stirrup or other step and a horizontal handhold on each side, approximately the full length of the cab, which will enable the enginemen to go from the cab to the running board in front of it—handholds and steps or stirrups to be securely attached with bolts or rivets; the distance between the step and handhold to be not less than 60 in. nor more than 72 in.



Typical Bagged Crown Sheet in a Firebox with Riveted Seams

In conclusion the report recommends that these appliances should be applied to all new locomotives before they are placed in service, that locomotives now in service without such appliances should be so equipped the first time they pass through the shop for classified repairs, as specified by the United States Railroad Administration, and all locomotives in service should be so equipped within a reasonable time.

CONVERTING CROSS COMPOUND LOCOMOTIVES TO SIMPLE

During the years 1905 and 1906 the Minneapolis, St. Paul & Sault Ste. Marie purchased a considerable number of cross-compound locomtives of the Consolidation type. These engines were among the heaviest of their class at the time they were built, the total weight in working order being 101 tons. At the present time they are still used in through freight service and in order to eliminate the unsatisfactory features of the compound, one of the class was recently converted into a simple locomotive using superheated steam. Tests conducted to determine the relative fuel consumption of the compound and the simple superheated engine showed that the change in the design resulted in a substantial saving of fuel.

For the purpose of the test two engines were chosen which were in practically the same mechanical condition. Engine 448 was a cross-compound, while engine 468 was superheated with simple cylinders. One engine crew was assigned to the test and was used on all the runs. In order to obtain a close check on the fuel used, approximately the correct amount of coal for the run was weighed and put into the coal space of the tender. An additional supply was weighed out into 100-lb. sacks and was carried on the back of the tender. The fuel used in firing up and before the test started was taken from the sacks and accounted for separately. After the main supply had been burned, sacked coal was used or in case the pit was not emptied, the remainder was removed and weighed. A record of the water used was made by means of a gage each time the tank was filled.

The division on which the test trains were run extends from Moose Lake to Boylston Junction, Minn., a distance of 38 miles. The regular tonnage for the cross-compound locomotives is 90 cars or 1,440 tons and the majority of the trips were made with this tonnage. On two trips with the superheated simple engine, the train was increased to 100 cars of 1,600 tons. Although the increase in the rated tractive effort of the simple over the cross-compound is only six per cent, these runs showed that engine 468 would handle 100 cars better than engine 448 would handle 90 cars. On hauls out of the ore mines, the regular rating for the compounds is 50 cars, but on test trips engine 468 hauled 55, 59 and 60 cars without any difficulty. Another trial run was made from Superior, Minn., to Glenwood, a distance of 200 miles. On this division the tonnage rating for the cross-compound engine is 2,200 tons, but in order to make the trip in less than 16 hours the train must be reduced to from 1,800 to 2,000. With engine 468 a train of 2,157 tons was hauled from Superior to Glenwood in 10 hrs. 7 min. actual running time, making an average speed of nearly 20 miles an hour.

The fuel performance with the two engines on the trips between Boylston Junction and Moose Lake are summarized in the accompanying table.

Engine No.	Test No.	No. of cars	Tonnage	Coal per 1,000 ton miles	Decrease for Engine 468 per cent	Coal per sq. ft. of grate per hour	Actual Evap. per lb. coal	Running time
468	1 and 2	90	1,440	124	13.9	78.0	6.93	1 h 32m
448	5 and 6	90	1,440	144	...	56.5	7.78	2 h 37m
468	3 and 4	100	1,600	128	...	80.0	6.96	1 h 52m

It will be noted that the actual evaporation per pound of coal with the superheated locomotive was 10.9 per cent less than with the saturated locomotive, due no doubt to the reduction in tube heating surface resulting from the application of the superheater. In spite of this, the superheated engine used 13.9 per cent less coal per 1,000 ton miles than the compound saturated engine.

The principal dimensions, weights, and ratios for the original and the converted locomotives are given below:

General Data

	Engine 448 (Cross-compound)	Engine 468 (Simple superheated)
Gage	4 ft. 8½ in.	4 ft. 8½ in.
Service	Freight	Freight
Fuel	Bit. coal	Bit. coal
Tractive effort	37,300 lb.	39,500 lb.
Weight in working order	201,500 lb.	197,800 lb.
Weight on drivers	174,000 lb.	169,800 lb.
Weight on leading truck	27,500 lb.	28,000 lb.
Weight of engine and tender in working order	318,400 lb.	314,700 lb.
Wheel base, driving	17 ft. 0 in.	17 ft. 0 in.
Wheel base, total	25 ft. 11 in.	25 ft. 11 in.
Wheel base, engine and tender	55 ft. 9½ in.	55 ft. 9½ in.
Ratios		
Weight on drivers ÷ tractive effort	4.67	4.30
Total weight ÷ tractive effort	5.40	5.01
Tractive effort × diam. drivers ÷ equivalent heating surface*	811.2	909.2
Equivalent heating surface* ÷ grate area	61.8	58.4
Firebox heating surface ÷ equivalent heating surface,* per cent	5.45	5.77
Weight on drivers ÷ equivalent heating surface*	60.1	62.0
Total weight ÷ equivalent heating surface*	69.6	72.3
Volume equivalent simple cylinders	11.45 cu. ft.	......
Volume both cylinders	15.65 cu. in.	......
Equivalent heating surface* ÷ vol. cylinders	252.8	174.9
Grate area ÷ vol. cylinders	4.08	3.00
Cylinders		
Kind	Cross-compound	Simple
Diameter and stroke	23 in. and 35 in. by 34 in.	22½ in. by 34 in.
Valves		
Kind	H. p. cyl., piston; l. p. cyl., slide	Piston
Diameter	......	12. in.
Greatest travel	6 in.	6 in.
Wheels		
Driving, diameter over tires	63 in.	63 in.
Driving, thickness of tires	3½ in.	3½ in.
Boiler		
Style	Ext. wagon top	327 sq. ft.
Working pressure	210 lb. per sq. in.	2,737 sq. ft.
Outside diameter of first ring	67⅜ in.	Ext. wagon top
Firebox, length and width	96⅛ in. by 70¼ in.	170 lb. per sq. in. 67⅜ in.
Tubes, number and outside diameter	332-2 in.	96⅛ in. by
Flues, number and outside diameter	......	70¼ in.
Tubes and flues, length	15 ft. 9 in.	178-2 in.
Heating surface, tubes and flues	2,739 sq. ft.	28-5⅜ in.
Heating surface, firebox	158 sq. ft.	15 ft. 9 in.
Heating surface, total	2,897 sq. ft.	2,089 sq. ft.
Superheater heating surface	......	158 sq. ft.
Equivalent heating surface*	2,897 sq. ft.	2,247 sq. ft.
Grate area	46.89 sq. ft.	46.89 sq. ft.

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

A NEW MEANS OF COOLING PISTONS.—A recent British invention has been made whereby the piston of an internal-combustion engine may be cooled by means of a draft of air circulating through a space in the piston. The draft is provided by means of fan blades on the engine flywheel. On either side of the hollow piston are ports which register with corresponding ports in the cylinder walls at the end of the stroke. A draft of air is thus forced through the hollow space in the piston while all the ports are in line.—*Compressed Air Magazine.*

THE HIGH COST OF TOOL BREAKAGE.—A complete record of total breakage kept by a far western American steel company shows convincingly the expense of putting good tools in the hands of careless or incompetent workmen and indicates that it is particularly heavy when numbers of new men are being put to work. Even in normal times the company found that the damage in tools is a big problem and it actually happened on one or two occasions that careless men destroyed in a moment tools far in excess of the value of their labor for weeks and months. Before labor turnover became a problem last fall, two tool room clerks with eight assistants easily dispensed the equipment required by 500 men, whereas toward the end of the year 39 were required and 11 men were engaged solely on grinding the tools.—*Scientific American.*

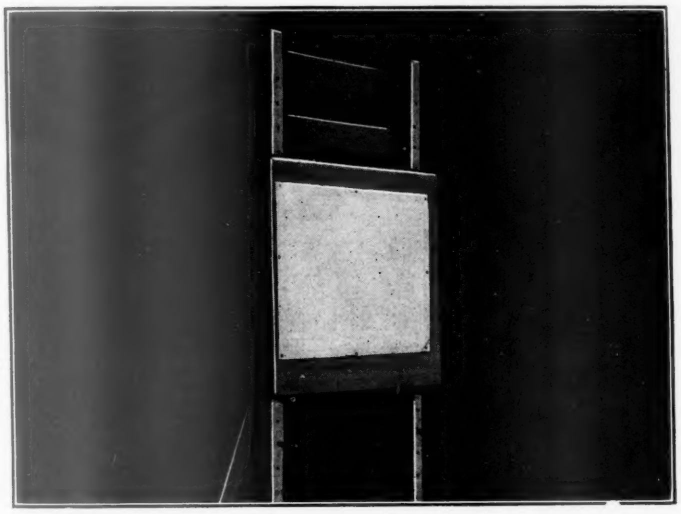
The Deflection of Staybolts

Movement of Sheets of Locomotive Fireboxes; Relative Action of Rigid and Flexible Bolts

BY GEORGE L. FOWLER

For many years the breakage of staybolts in locomotive boilers has been a source of danger and this danger was emphasized very soon after the locomotive took its rapid leap ahead in size when it was found that it was no longer necessary to limit firebox dimensions to the space available between the driving axles and the frames.

The increase in the length of fireboxes caused a corresponding increase in staybolt breakages. It was assumed that this breakage was caused by the bending of the staybolts due to a variation in the expansion of the two sheets which they connected, by which they were strained beyond their elastic



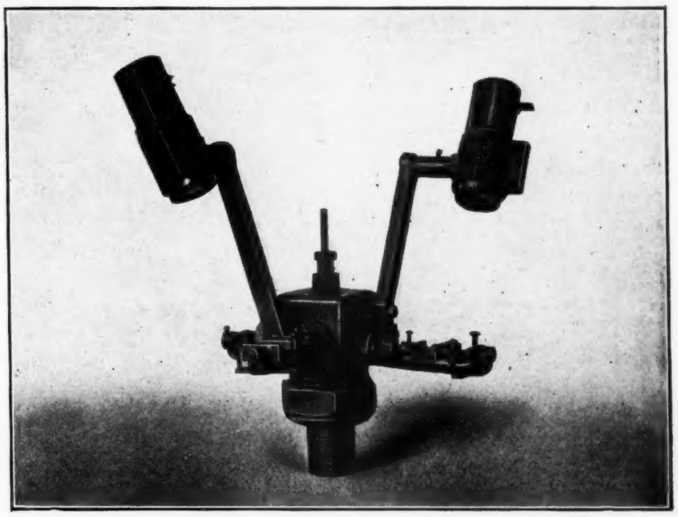
Screen for Recording the Movement of the Beams of Light Reflected by the Mirrors

limits, thus producing a progressive fracture. It was also assumed when the boiler was working under normal conditions that staybolts were straight in their normal position and were subjected only to that stress which would be imposed upon them by the steam pressure acting upon the plates. It was further assumed that the deflection of the bolts occurred during the process of raising steam, and that, because the breakage occurred at the ends of the firebox, there was a neutral vertical zone at the longitudinal center of the firebox along which there was no staybolt deflection. But, while assumptions and theories were as plentiful as autumn leaves, there was no data on the subject and no one knew. The most that had been done, in the way of investigation, was to determine that, under certain conditions, there was an upward and downward movement of the crown-sheet and the tubes.

The object of the investigation described in this article was to determine, by actual measurement, the amount of relative movement between the inner and outer sheets of a locomotive firebox and also when that motion occurred as well as its general character. There was no precedent upon which to proceed nor any thing more than the vaguest of guesses as to the amount of motion to be looked for—except that probably it would be very slight.

The apparatus used was of a very simple character and involved only one moving part. Its work consisted of resolving the motion of the inner sheet relatively to the outer one, into its vertical and horizontal components and projecting them on a screen. These were afterwards recombined to plot this relative movement in the form of a diagram. The mechanism of the apparatus consisted of two small metallic mirrors that were first adjusted to a perfect parallel. A beam of light from a narrow slit was reflected back to a screen. One mirror was fastened rigidly to the outer sheet and traveled with it and remained parallel to it at all times. The main body of the apparatus including all lenses and adjustments was also attached to this same sheet. The second mirror was suspended on the main body of the apparatus but was so connected to the inner sheet that, if any motion took place between the two sheets, the mirror would be rotated. This would cause a separation of the two beams of light on the screen and the amount of separation was a measure of the relative movement of the sheets. The calculation of the motion was simply dependent upon the distance at which the screen was set from the mirrors.

The first setting was such that separation of 1/16 in. indicated a relative movement of 1/20,000 in. between the two plates. This was found to give finer measurements than were needed and the whole of the work, hereinafter detailed, was done with the screen so set that each 1/16 in. separation



The Original Apparatus

of the beams of light indicated a relative movement of 1/6400 in. between the plates.

The first boilers subjected to investigation were of the radial stayed type as illustrated in the accompanying engravings. There were two of them that were identical in construction except that one was fitted with a complete installation of the ordinary rigid staybolts and the other with a complete installation of the Tate flexible staybolts.

The firebox dimensions were:

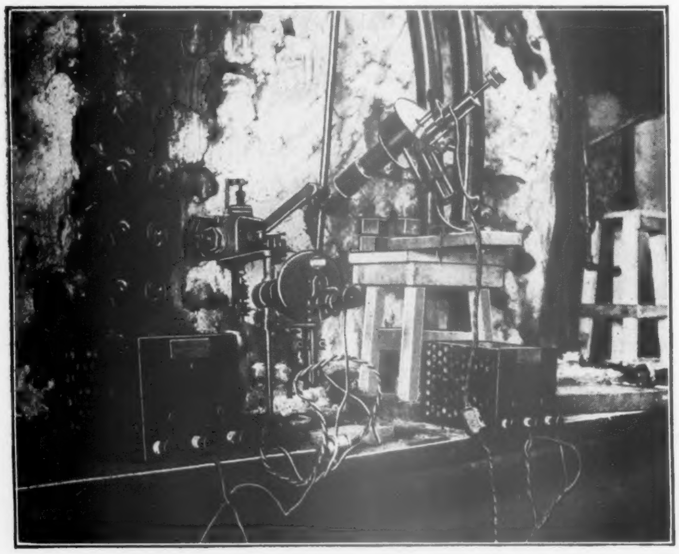
Length at bottom	8 ft. 3 in.
Length at top	8 ft. 8½ in.
Width at bottom	5 ft. 2 in.
Width at top	4 ft. 8 in.

The general arrangement of the apparatus is shown in the illustrations. Each firebox was fitted with four water tubes for carrying a brick arch which was located as shown.

New fireboxes had been placed in each of the boilers immediately prior to the tests so that all of the sheets affected were fresh and clean.

SCOPE OF INVESTIGATION

The scope of the investigation was as follows: Determination of the difference in the movement of the inner and outer side sheets of the firebox at eight points; the difference in movement of the crownsheet relatively to the roofsheet; of the back firebox sheet relatively to the back head; of the throat sheet relatively to the front tubesheet and of the front tubesheet relatively to the shell. Determination of the temperature of the fire and water sides of the inner firebox sheet at the side at five points; the water temperatures in the throat at the foundation ring and in front of the arch tube openings, while steam was being raised in the boiler and while it was at work.



The Original Apparatus Applied to a Radially Stayed Boiler

Two methods of conducting the tests were employed. In one the fire was kindled and the fireman instructed to raise steam in the manner usual in regular roundhouse work. When the safety valve opened, the fire was maintained so as to keep the valve blowing for from 10 to 20 minutes, when the fire was dumped and the boiler allowed to cool. The time required to raise the steam pressure to the blowing off point varied from 50 to 90 minutes.

The second method was the same as the first insofar as the raising of steam pressure is concerned; but, when this was done, the distribution valves having been removed from the locomotive, the throttle was opened and, with the injector running to capacity, the fire was maintained so as to hold the steam pressure at the blowing-off point—195 lb.—for about 30 minutes and then the fire was dumped and the boiler cooled.

In raising steam the shop blower, carrying a pressure of about 60 lb. per sq. in., was attached to the locomotive and used until the boiler pressure reached that amount, after which the regular locomotive blowers were used.

In cooling the boiler steam was blown out so as to cause a fall of pressure of about 1 lb. per min., taking about three hours to reduce the pressure to zero.

In making the tests the apparatus was successively located at the staybolts marked 1, 2, 3, 4, 5, 6, 7 and 8.

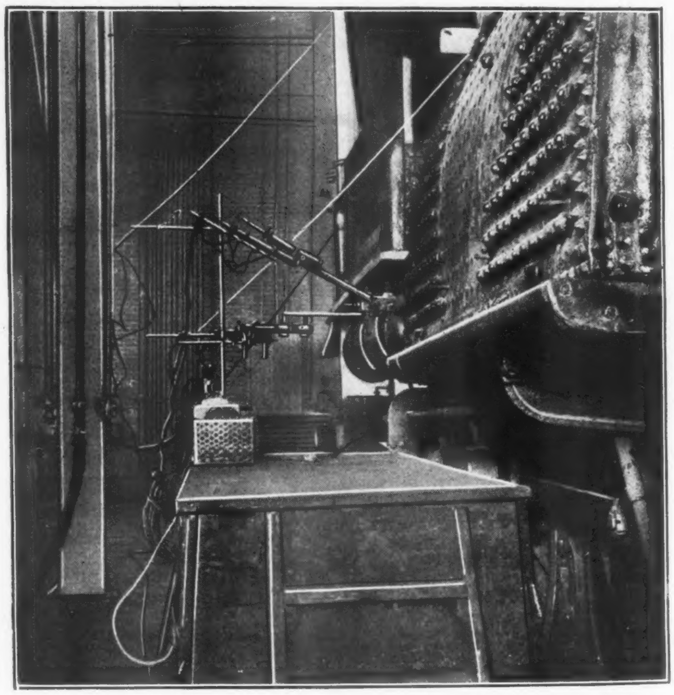
Lack of space will make it impossible to enter into the details of all of the work done, and only enough of it will be described to give an idea of what was learned and the basis for the tentative conclusions that have been reached. I say "tentative" because the investigation has not yet been completed and full information is not available as to how all kinds of fireboxes act in service. The reasons for this will appear as the description proceeds.

In the tests at staybolt No. 1, which was at the front upper corner of the firebox, the first method of testing was used, and the results obtained are shown in the diagram. In this, as in all diagrams to follow, the scale of movement is in thousandths of an inch, on either side, vertically or horizontally, of the starting point at O which denotes the normal position of the two sheets when the boiler was cold at the commencement of the test.

In the first test at staybolt No. 1, it will be noticed that the initial movement of the inner sheet relatively to the outer one was downward and to the rear, and it will be seen later that this initial downward movement was characteristic of nearly all of the tests. Both the downward and rearward movements were, however, quickly reversed and the inner sheet moved up and to the front.

There are features brought out in this diagram that are characteristic of all of the others and to which attention may be called here. One is that the sheets do not expand and return to their normal position when a steam pressure is raised; a second that the sheets are in constant motion relatively to each other at all times, and that the relative motion is much greater with a boiler fitted with flexible stays than it is with one having rigid stays.

In the case of staybolt No. 1, this difference in movement



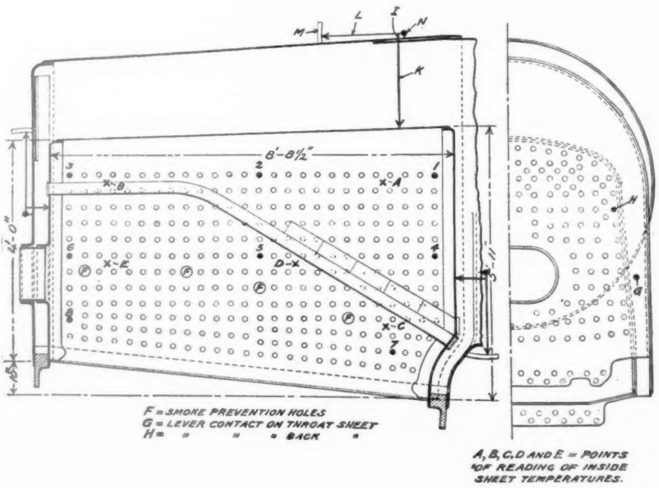
The Redesigned Apparatus Applied to a Boiler Having a Wootten Firebox

is very marked and the total maximum deflection of the flexibly stayed boiler is more than twice that of the rigidly stayed. If the variation of vertical movement alone is taken into consideration, that of the flexibly stayed boiler is more than five times as great as that of the rigidly stayed. It will be seen, too, that there is a general progressive movement until the blowing-off pressure is reached, then, while that is being maintained, there was a movement of the sheets to and fro, with a general return movement towards the original normal position after the fire was dumped and until the boiler had been cooled to the disappearance of all pressure.

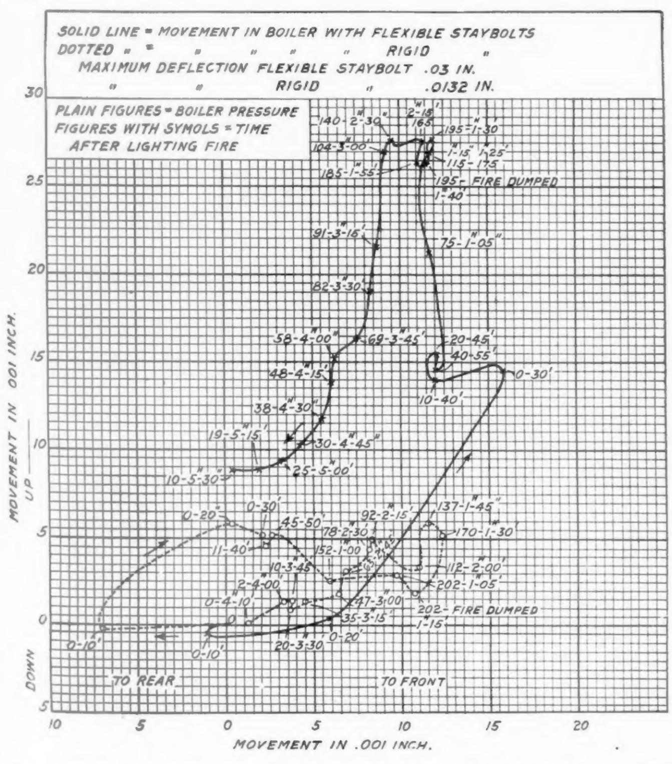
In this first diagram, the rigidly stayed sheet returned to within about .001 in. of its original position, while the

flexibly stayed sheet was out about .009 in. at the conclusion of the test.

Owing to the fact that, in rigidly stayed boilers, the breakage at the upper front and back corners of the side sheet was much greater than it was midway between the two, it has been assumed that there was a neutral point on this midway line, on which the staybolt deflection was little or nothing. That this surmise was approximately correct is shown by the diagram of the tests made at staybolt No. 2 which was at the center of the upper row. Here, in both the flexibly and rigidly stayed boiler, we find that the horizontal motion was much less than the vertical, indicating an approach to a neutral zone, but, as at staybolt No. 1, we find the horizontal movement of the sheet to be something more than twice as much on the flexible as on the rigidly stayed boiler.



Arrangement of Firebox in Lake Shore & Michigan Southern Locomotive for Temperature and Expansion Tests

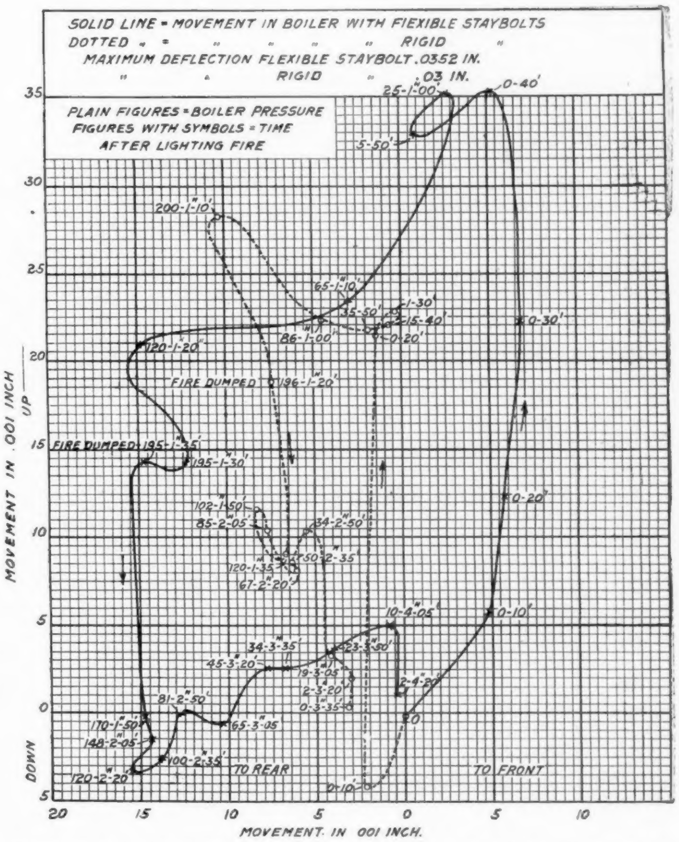


Staybolt No. 1 Top Row Front—Lake Shore & Michigan Southern Locomotive

It is impossible to state positively that there is no neutral line with the rigid boiler, but the statement can be made regarding the flexibly stayed boiler. Of course, if the front end of the inner sheet goes to the front and the back end to the rear there is, possibly, an instantaneous neutral line, but it must be in constant motion and, therefore, does not fulfil the preconceived ideas as to the neutral line.

From a study of the curves of movement of the staybolts examined on the rigidly stayed boiler, the evidence is that the same holds true for that boiler, namely, that the point of no movement—that is, where the two sheets occupy their original or normal positions—is in constant motion. This means that all staybolts are being constantly bent back and forth, which is corroborated by the determination of sheet temperatures which formed a part of this investigation.

In the case of staybolt No. 3, which was at the back end



Staybolt No. 2 Top Row Center—Lake Shore & Michigan Southern Locomotive

of the top row and close to the back head, there was a sudden and rapid movement of the inner sheet to the rear on both rigidly and flexibly stayed boilers, and the maximum of the horizontal movement was reached in a very short time after the kindling of the fire; the rigidly stayed boiler reaching it in 10 and the flexibly stayed in 20 minutes.

Without going into details of the other tests, it may be stated that while the amount of movement varied, the character of the motion did not vary essentially and the same relationship between the rigidly and the flexibly stayed boilers was maintained.

When tests were made at the next to the bottom row of staybolts, however, a matter developed that proved to be of very great importance. Attention has already been called to the fact that in the test at staybolt No. 1, the first apparent motion of the sheet was downward, but as this only amounted to .00075 in. it was regarded as a negligible quantity. At the bolt below it, (No. 4,) there was a drop of .00225 in. which was still not enough to excite suspicion, but at No. 7 this drop increased to .009 in., apparently indicating a downward movement of the inner sheet at a point

only a few inches above where it was riveted to the mud ring. Evidently this is an impossibility, and the only explanation to be made was that the sheet had buckled and, by throwing the apparatus out of line, caused it to indicate a downward movement.

These first tests therefore must be regarded as showing but two things: the constant movement of the staybolts while in service and the relative movement of the sheets of a rigidly and flexibly stayed boiler.

With no precedent to serve as guide, the apparatus had been designed on the assumption that the two sheets would remain parallel to each other at all times. When this evident buckling was discovered the apparatus was redesigned so as to indicate not only the movement of the sheets but any buckling that might take place.

This redesigned apparatus was used on some boilers having a Wootten firebox with general dimensions as follows:

Length	10 ft. 1 in.
Width at foundation ring	8 ft. 11¾ in.
Height at front	5 ft. 8 in.
Height at back	5 ft. 1½ in.
Depth of combustion chamber	5¼ in.
Number of 2 in. tubes	411
Length of tubes	14 ft. 6 in.
Inside diameter of shell (front)	6 ft. 1 in.
Height of roof over crown (front)	1 ft. 6¾ in.
Height of roof over crown (rear)	1 ft. 9½ in.

There were three rows of expansion stays at the front to hold the crown sheet and eight on each side of the center line as shown in the drawing. The staybolts were spaced on four in. centers and the rigid bolts were ⅞ in. in diameter.

The two boilers were not as distinctly flexibly and rigidly stayed as were those used in the first tests. The boiler which has been designated as the rigidly stayed had a number of Tate flexible staybolts as indicated in the drawing. In the throat sheet all of the bolts in the seven upper rows and all of the bolts in the outer row, were flexible. In the side sheets there were 15 Tate flexible bolts in the front row, and 12 other scattering Tate bolts that had been put in for repairs, in the locations shown in the drawing.

The other boiler, which is designated as the flexibly stayed boiler, had a complete installation of flexible bolts in the throat sheet, with the exception of 20 bolts near the foundation ring that were rigid as shown in the drawing. Of a total of 510 staybolts in the side sheet, 248 were flexible bolts. These were located in equal numbers and with the same arrangement at the front and back end of the firebox. There were six in the top horizontal row next to the crown sheet, with a gradual increase from the top to the bottom as shown in the drawing and the photograph. This left a wide section of firebox at the center that was stayed by rigid bolts and which, evidently, exerted an important influence on the results as will be pointed out later.

The staybolts at which these tests were made were located at the numbered points 1 to 9 on the two drawings, and the tests were made as before, by raising steam, holding the throttle open for 30 minutes and then blowing down at the rate of 1 lb. per min., readings of the sheet movements having been made during the whole period at 10-minute intervals.

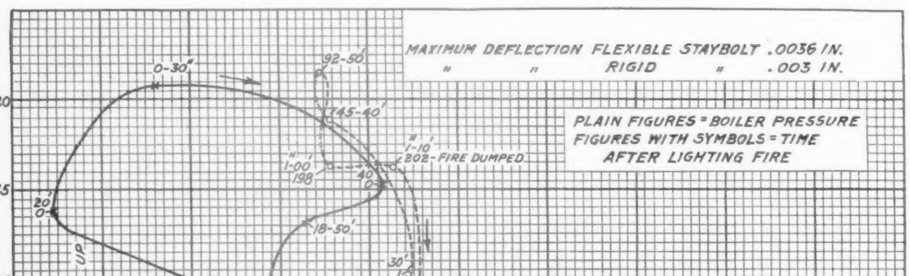
Whether it is because the apparatus used on the radially stayed boilers only indicated the apparent motion of the sheets while that used on the Wootten boilers indicated the actual movement, that the diagrams of these movements are much more complicated for the latter boilers cannot be stated positively. That the buckling that evidently did occur in the sheet of the radially stayed boilers had its effect on the actual movement of the sheets is a reasonable supposition, but certainly there is a great difference in the character of the two.

COMPARISON OF TWO TYPES OF BOILERS

Let us compare those for staybolts No. 1, in the two types of boilers: In the radial stayed boilers there is a steady even motion of the sheet with little or no doubling back and looping over itself. There was a constant movement, but it was, in the main, a progressive movement ending with an apparent deflection of about .008 in. from the starting point of the flexibly stayed boiler.

The rigidly stayed boiler was a little more complicated in its motion, but still not at all confusing, and ended with a deflection of a little more than .001 in. from the starting point.

The diagram for the corresponding staybolt of the Wootten boiler is a mass of knots and loops and back doubling. This is especially true of the period prior to the development of the first steam pressure. This appeared at the point marked O-2H-10′ in the diagram when steam began escaping from the whistle valve. Then there was a rapid upward movement for 20 minutes until a pressure of 75 lb. was reached followed by an equally rapid forward and downward movement during a quick building up of the pressure to 200 lb. Then came a quick recovery horizontally during the period that the throttle was open with only a very slight change in vertical position between the beginning and the end.



Staybolt No. 3 Top Row Back—Lake Shore & Michigan Southern Locomotive

This movement is easily explicable if the tube action as indicated by other tests is taken into consideration. It was found that during the early period of raising steam the tubes were heated more rapidly than the shell with the result that the back tube sheet and with it, probably, the front end of the firebox was pushed to the rear. This explains the slight rear-

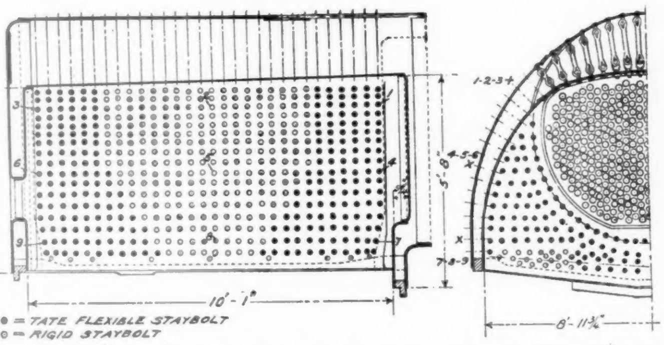
ward movement of the staybolt at the starting of the test. Then, as the water became heated there was a tending toward equalization of the temperatures of the tubes and the shell. This resulted in a relative forward movement of the tube sheet permitting the firebox to expand normally. Then, when the throttle was opened, there was a rapid increase of firebox temperature resulting in a corresponding increase in the temperature of the gases in the tubes themselves, which again pushed the tubesheet to the rear carrying the front end of the firebox with it. Then followed the looping and doubling of the movement during the cooling down, ending with the staybolt a little more than .002 in. from its original position.

In the rigidly stayed boiler the entanglement of the line of the movement is equally marked and is of the same general character, but, as in the other cases, the extent of the movement is much less.

This condition holds throughout the whole range of the work, varying in extent with the location of the staybolt and the method of staying. In general the movement was greater at the ends and upper portions of the firebox than at the center and lower portions.

There is another matter in connection with the rigidly stayed boilers that does not fully appear in the diagrams: The evident reason for the lesser deflection of the rigidly stayed boiler is that it is rigid. The staybolts tend to hold the sheets in one position and resist all tendency to move, and this manifests itself in the jerky character of such motion as takes place. That is to say, there are sudden variations in the distance from the original position which indicate that the stays resist the effect of the expansion of the sheet to move them, possibly buckling the sheet, and then when the pressure becomes more than they can carry, they suddenly yield.

The one point where a close comparison and check between the radially stayed and Wootten type is possible is in the movement of the staybolts when the boiler is in service. In both cases it was found that the sheets were in constant motion relatively to each other from the instant the fire was built until the boiler was cold. Also the extent



Delaware & Hudson Locomotive No. 813 with Flexibly Stayed Wooten Firebox

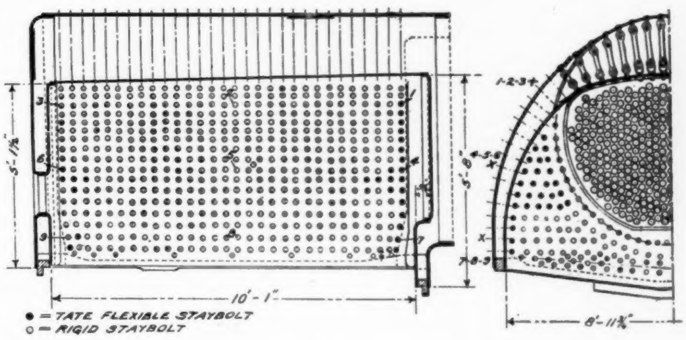
of the movement was much greater in the flexibly stayed boiler than in the rigidly stayed.

The character of the movement was, however, apparently quite different in the two types of boilers. There was more bending to and fro in the Wootten as well as a much greater movement. This is especially manifest in staybolt No. 1, where the maximum deflection of the flexible bolt in the Wootten type was about nine times that of the radially stayed, and this amount entirely in a vertical direction.

There may have been several reasons for this. The Wootten firebox was 1 ft. 4½ in. longer and 1 ft. 1½ in. deeper and the staybolt was 8 in. long as against 5¾ in. for the radially stayed boiler. Each of these items would tend to increase the deflection, while the comparatively small amount of horizontal deflection is explicable from the fact that there was a complete installation of flexible bolts in the radially stayed boiler, while, in the Wootten type there was a line of 18 rigid bolts in the central section that tended to stiffen the boiler and prevent a relative movement of the sheets. These are suggested as reasons, not as demonstrated proofs.

The main fact, however, stands out very prominently that the character and amount of the staybolt deflection is quite different in the two boilers. As yet, there is not sufficient data accumulated to be able to state definitely as to just why this is so, and what should be done to the general design of one or both of the boilers to put the least possible strain on each.

In the matter of the buckling of the sheets caused by the



Delaware & Hudson Locomotive No. 794 with Rigidly Stayed Wooten Firebox

combined action of sheet expansion and resultant staybolt deflection, it was found that the buckling was greater with the flexible than with the rigid bolts; but, it must be borne in mind that the deflection was also greater, and a study of the details shows that the ratio of the buckling of the flexibly stayed to the rigidly stayed was less than the corresponding ratio of deflection. In other words, given a fixed amount of staybolt deflection the buckle put in the sheet would be less with a flexible than with a rigid staybolt.

While at work on the rigidly stayed boiler having the Wootten firebox an attachment was made in the space just ahead of the No. 5 staybolt. As might have been expected, the actual movement of the sheet was about the same as at the No. 5 staybolt but there was less buckling. This developed the probability that, in this long and wide firebox at least, the whole sheet, while under steam pressure, assumes a series of shallow corrugations that hold it out of alinement with its original shape, and which are sweeping over it in waves, as it were, according as the sheet expands or contracts. The depth of the corrugations is slight and the angle made by the sides of the same with the original line of the sheet is never as much as one degree. The greatest angle obtained on the Wootten type was 48 minutes 52 seconds with a general average for all points tested on the flexibly stayed boiler of 7 minutes 29 seconds.

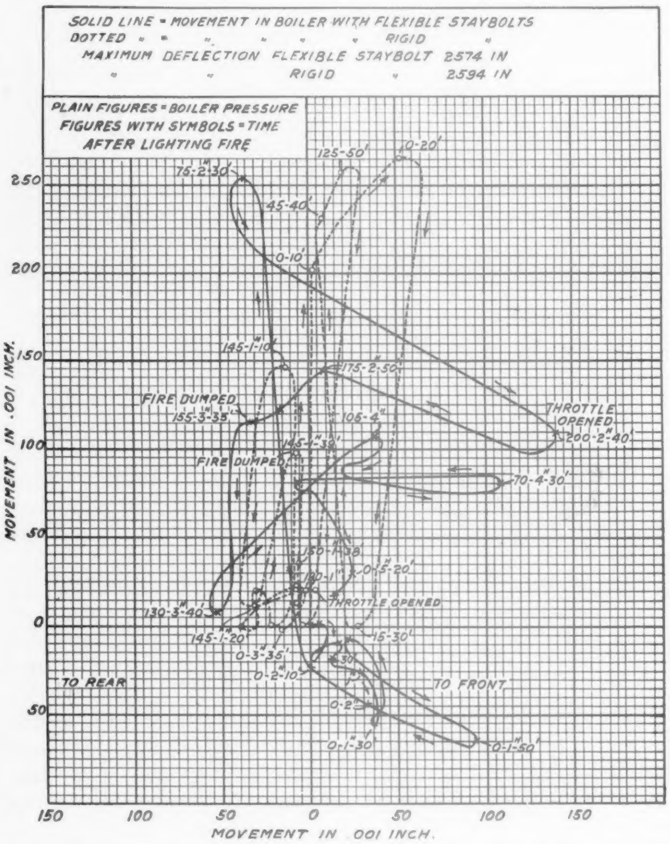
It is also possible that the buckling of the sheet might be appreciably decreased by a change in the original adjustment of the flexible staybolts, and also that there might be an increase in the deflection of the bolts. The suggested methods of accomplishing this is to give a little more play in the head of the bolt and the allowing of a little slack under the heads in the first place. This would permit of an easier adjustment to the movement of the sheet during the period of raising steam, when there is no load on the bolt, and the allowance of a little freedom of angular motion when the sheet and bolt are under strain.

Other matters were taken up in connection with this investigation for which there is no space to deal at this time. There were the effects of cold air in the firebox on sheet temperature and the lack of circulation in the water leg.

CONCLUSIONS

The fundamental facts fully brought out were that the staybolt deflection is much greater in a flexibly stayed boiler than in a rigidly stayed boiler, that certainly during the whole period of operation and probably until the boiler temperature had reached that of the atmosphere the staybolt is in constant motion as evidenced by the fact that, out of the hundreds of measurements taken, there were no two consecutive measurements alike; that the two types of boiler construction (Wootten and radially stayed) have quite different effects on staybolt deflection; and that firebox temperatures and the action of the tubes have a marked influence on staybolt deflection at the front end of the firebox.

These tests also showed in a marked degree the extreme sensitiveness of the plates to changes of temperature. For example, a cold boiler may be filled with water of any temperature from cold to boiling and there will be no relative motion between the sheets. But let the fire be laid and a piece of lighted waste thrown in to ignite it, and it has, thus far, been impossible to get a reading before the sheets would show a movement, though this has been done within ten seconds from the time of the ignition of the waste.

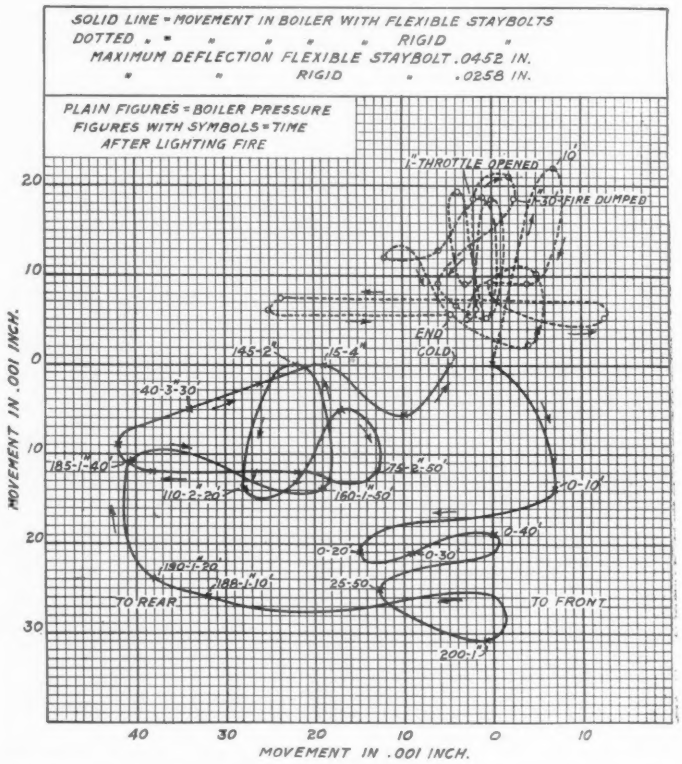


Staybolt No. 1 Top Row Front—Delaware & Hudson Locomotive

This investigation is merely indicative and not conclusive. The absence of any data upon which to estimate the probable movement and buckling of the sheets made a redesigning of the apparatus necessary, and the use of boilers with a mixed assortment of staybolts in the second case, gave results that would probably be greatly modified were boilers with complete installations to be used. But there is this indication, that the boiler will expand and the staybolts deflect if they have a chance, and that this chance is much greater with a flexible bolt than it is with a rigid one.

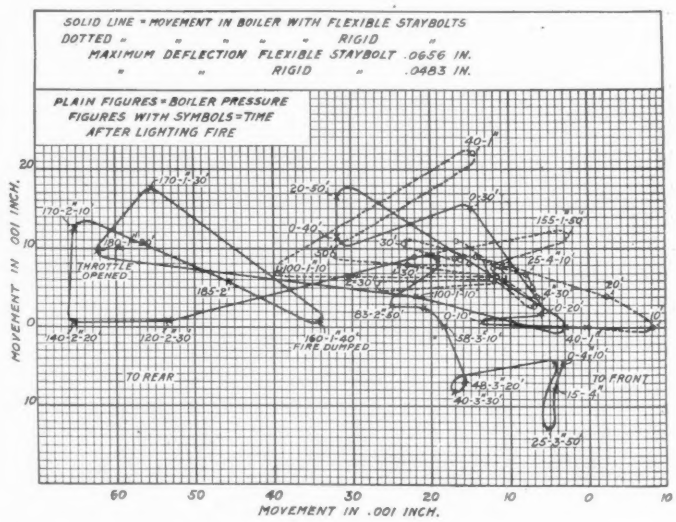
As has already been intimated, the difference in the conditions of operation of the apparatus makes a clean-cut comparison between the Wootten type and the wide firebox radially stayed boiler impossible. But the impression left by the test is that the Wootten firebox is much more rigid than the wide firebox when rigidly stayed with the radial stays, and that if it were given a complete installation of flexible bolts the difference between the two would be very much greater than that indicated in these tests.

In every case the extreme sensitiveness of the sheets to any changes of firebox temperature was noted. This fully explains the constant bending motion to which the bolts are subjected while the boiler is at work.



Staybolt No. 2 Top Row Center—Delaware & Hudson Locomotive

It naturally follows from this that a boiler which is so built as to permit the sheets to expand under the influence of temperature changes, will put less stress upon the staybolts and sheets than one where such freedom of motion does not exist. There is no reason to think that there was any great difference in the temperatures of the sheets of the two boilers, and yet, as I have already indicated, there was



Staybolt No. 3 Top Row Back—Delaware & Hudson Locomotive

a marked difference in the movements of the staybolts and the sheets. If a given change of temperature produces a definite change of dimension in the sheet, anything that prevents this change must itself be subjected to stress and must put a similar stress upon the sheets. Hence, so far as these investigations have been carried, they indicate the value of using the flexible in preference to the rigid bolt as a means of reducing stresses in the firebox.

There is one point that cannot be expressed in cold figures and that is the impression that this work makes on observers. After watching the delicate and sensitive movement of the sheets and staybolts and the difference in the action of the flexible and the rigid bolts, everyone was greatly impressed with the superiority of the flexible bolt as a means of reducing the probable stresses that the several parts of the boiler are called upon to sustain. The progress of this work has driven home in a convincing manner the advantages of flexibility in boiler construction.

PROGRESS AND STANDARDIZATION

Development of Brake Beam and Air Brake Illustrates Need for Free Play of Inventive Genius

DURING the hearings before the House Committee on Interstate and Foreign Commerce, a number of manufacturers of railway equipment presented voluntary statements as to certain phases of the question of the disposition of the railroads at the expiration of federal operation. During their appearance before the committee these men were practically all asked for their opinions relative to standardization of railway equipment. In response to these questions the following letter was addressed to Representative Esch, chairman of the committee, by Alba B. Johnson, president of the Railway Business Association. The letter, which presents a concrete illustration of the part competition and initiative have played in the rapid development and improvement of railway facilities, is as follows:

Manufacturers of railway equipment upon concluding voluntary statements before your committee were asked by you their opinion regarding standardization. They replied that they favored interchangeability of car or locomotive parts through standardization of dimensions, but regarded it as essential to progress that there be variety of design and ocmpetition among inventors and developers of appliances.

It is due to you and to ourselves that a fuller explanation of our view and of the reasons underlying it should be made. By conference and correspondence we have obtained the knowledge and judgment of members of our association and others. In the subjoined statement we endeavor to demonstrate that competition is essential to progress in service and in economy, that voluntary standardization by the railways acting collectively has long afforded and can continue to afford all desirable interchangeability, and that diversity of design is the indispensable condition for exertions by inventors and by developers of appliances. As bearing upon diversity of design, a description is given of a typical competitive appliance, the brake beam rigging. Authorities quoted in the statement are connected with the several concerns which make such rigging, and speak in response to our request.

As a factor in progress what is at stake is competition. If Congress adopts the principle set forth in Section 9 of the Cummins Bill (S. 2906), which deals with consolidations, the 20 to 35 ultimate systems will be so formed that "competition shall be preserved as fully as possible." The government determines rates, in which competition has therefore largely ceased. What remains is competition in service and economy.

Such competition in the past has been maintained between railways and between makers of devices. The makers' occupational motive for maintaining competition in both directions is self-preservation; but the public has a vital interest in the preservation of these manufacturing enterprises and in the continuance of competing railway systems, since upon such enterprises and such railway competition depends quality and cheapness of transportation performance.

From economical operation, the public benefits through larger railway income, stronger railway credit, more vigorous improvements of and additions to facilities and through a tendency to keep down rates.

Standardization means the elimination of competition.

Insofar as standardization is desirable for the sake of practical stability and convenience of repairs, the railroads themselves, with the co-operation of the manufacturers, have in the natural course of business adopted and employed it. A standard specification in vogue on American railways is not the edict of a potentate or board of potentates. It comes up from below. It must make its way into general approval before it can have the force of a regulation which the minority will observe. So far as the manufacturer goes, the matter of applicability, of usability, which is the same thing as interchangeability is out of his hands without action of government.

For several decades the Master Car Builders' Association and the Railway Master Mechanics' Association (locomotive), scientific institutes of railway officers, have annually added to the appliances whose dimensions and requirements for performance are "specified." These the American Railway Association, as it existed prior to government control, recommended to all the roads. Generally, they were put into effect as soon as announced.

The need of standardization of locomotives is almost wholly imaginary. A locomotive rarely leaves the road owning it or even the division for which it was built; hence in time of peace and almost entirely in time of war all locomotive repairs are made at home.

As to cars, interchangeability has been made universal in the United States. Accompanying this statement we present to your committee copies of two dictionaries issued annually by the Simmons-Boardman Company, publishers of the *Railway Mechanical Engineer,* one dealing with locomotive appliances, the other with car appliances. The latter part of each book contains the standards referred to, with pictures and drawings. From these books your committee can derive a conception of the extent to which the railroads when occasion required have standardized voluntarily.

To grasp the significance of the burden which a developing mechanical practice sustains in transportation progress, it is necessary to bear in the mind the fundamental of railroad economy.

In freight, the problem is the number of tons that can be hauled by one locomotive with one crew—in a word, the train-load. Possibly the largest single factor in the notable prosperity of such a road as the Union Pacific has been

the success of the management in attaining heavy train-loading. It was in pursuit of this economy that the late Mr. Harriman gave his days to experiment and devoted hundreds of millions to capital improvements. For augmentation of train-load, railroads in all parts of the country which had been permitted to accumulate the investment basis have poured out expenditures. They have built larger and stronger cars. They have constructed more powerful engines to haul the larger cars and more of these cars to the train. They have provided heavier roadway, rails, and bridges to sustain the enormously more ponderous train and cargo.

These expenditures, by reducing the cost of drawing freight per ton per mile, not only paid for themeselves, but so far offset the rising cost in wages and material as to postpone for years before 1910 the necessity for asking that freight rates be raised. The trainload as a foundation basis of railroading explains the despair of managers when employees proposed extra men in crews and a limit on length of trains.

Passenger trains have been made heavier also. More persons are carried to the car. Steel has taken the place of wood for safety. Speed has been increased for convenience.

To all this development there has been at every stage and in every phase a mechanical limit. For instance, the movement of the train must be controlled. The engineer must be able to slow down or stop in any emergency. That is to say, railways can progress in economy of operation no faster than the development of the brake. The air brake of the 60's replacing for more exacting uses the hand brake, achieved a stupendous advance; but stopping the toy trains of that era was to the stopping of the 100-car train of 125-ton loaded cars of today what the air brake of 1870 was to the air brake of 1919. Progress in the trainload and in the brake has gone hand in hand.

Even in the years when because of patent protection there was only one maker of air brakes, competition was an ever-present influence.

First there was the competition between railways. The most progressive-minded of the managers were perpetually engaged in rivalry for cheaper operation. If practice had been standardized for all lines no departure could have been undertaken on any of them until the whole national system, perhaps a central omnipotent board, could be persuaded. Cars of a certain capacity would have been obligatory until all new cars for all lines contracted for after a specified date might be built larger. Territorial and topographical contrasts in conditions confronting the several lines might imperfectly and tardily be met. The working of this tendency in practice can be observed in the government standard cars allocated to some roads which had long since adopted larger capacity as best suited to their special problems.

Second there was the potential competition of makers who might bring out competing brakes sufficiently original to convince the patent office. A rival actually established itself, though it now in part covers its patent situation by a license arrangement. What kept one concern so long alone in the field was that it diligently developed improvements—in short, it acted as it would have had to act if competition had been actual instead of merely potential. A vivid form of potential competition was that of makers ready to enter the field the moment patent rights expired. To maintain its commercial position the single maker long before each such expiration abandoned the air brake of yesterday and substituted a new device, protected in turn by new patents. The public was benefited because the essential advantage which induced progressive railways to try and use the newer appliance was the net saving in cost of operation through enlargement of the trainload.

A significant feature of the standard vehicles built by the United States Railroad Administration was the effort, in some cases successful, to use an appliance upon which patent rights had run out and thus to exclude from the bidding more recent inventions still protected. From the point of view of the public this is penny wise and pound foolish. It attains a little immediate cheapness. In doing so it exterminates by starvation the breed of inventors whose work is to promote not alone little economies but great ones.

An illustration more typical than the air brake is its adjunct, the brake beam. In what follows it has been thought convenient to employ for concrete illustration one appliance rather than several. For this purpose the device selected is the brake beam. This appliance is attached both to locomotives and to cars. Rigid standardization of its dimensions and of its strength is necessary and is enforced. From six to a dozen types are in use, while unsolved problems with regard to it are today the object of study and experiment. A somewhat full description of this rigging will facilitate an understanding of subsequent references.

The air brake can develop no faster than the beam. For between the air cylinder, whose piston is operated by pressure initiated in the locomotive cab, and the metal shoe which in action is forced against the wheel, there is a mechanism which directly applies the power to the shoe. A failure of that mechanism puts the brake out of commission.

The cylinder piston operates a rod located under the vehicle midway laterally, and by a system of levers moves the two, three or four trussed brake beam structures toward the pairs of wheels which they are to brake.

The performance which is expected of the beam rigging is this: that it receive the cylinder power; that it move so that simultaneously the shoe, which is fastened to it, will be pressed against the wheel; and that it stand the strain.

It is in standing the strain—that is, in the dependability and durability—that progress has been made and is still promised in the brake beam. If a manufacturer claims superiority for his type it is to those qualities that he refers.

The Master Car Builders' standards tell him how many inches the beam must measure from tip to tip and throughout its external outline in order to fit the various cars. They prescribe the height at which the beam must hang above the rail. They require specified dimensions and locations for certain parts of trussed structures. Consequently when a car off the rails of the owning road is found with a damaged brake beam and the road on whose rails it is sojourning is addicted to a beam of another type, the defective beam can be replaced by one carried in stock by the road which does the repairing.

The argument in favor of standardization is that while interchangeability of beams as a whole is maintained with variety of detail, each several part of the beam structure cannot be replaced by a part from another type of beam, but the whole beam must be substituted. Another view prevails. This is that serviceable and safe brake beam repairs are only made when the parts of the beam structure have been put together under the same tests and conditions as surround the manufacture, inspection and acceptance of new beams; whereas such conditions are not and cannot be present on yard repair tracks. The discarded beam is not wasted. It is subsequently carried to a place where under rigid conditions qualified mechanics restore it; and it takes its course of standard inspection like a new beam before it can again be placed on a vehicle.

In their requirements the Master Car Builders' Association includes loads that beams shall successfully carry; but the means by which the maker shall impart the specified power of resistance to the beam and its parts is within his own province. That is the field in which progress lies.

The original brake beam was wooden. As trainloads began to enlarge it was seen that a wooden beam strong enough for the new conditions would be a monstrosity in

size. Mr. C. F. Huntoon writes that "the best design of truss metal beam 15 years ago weighing approximately 63 lb., carried a load of 6,500 lb. at 1/16-in. deflection, this deflection being the maximum allowed by the M. C. B. Association, while today a beam of 77 lb. weight, or 20 per cent increase, will carry a load of 15,000 lb. at 1/16-in. deflection, an increase of over 125 per cent in strength and efficiency." Mr. Huntoon attributes such progress "to specialists who have directed their efforts to some one device or detail—each vying with the other to produce an article of superior merit;" and he says, "without this competition and the protection afforded by letters patent, there would be no fast schedule trains and boats, no telephones on the desk or automobiles for convenience or pleasure; in fact, the industrial progress of this country has been stimulated by and is largely due to these very factors."

The advance proceeded through various forms in metal. At first light metal beams met the situation, beginning with a trussed structure of pipe. Further increase in train weights led from year to year to development of more adequate trussed brake beam structures by various manufacturers, differing in the various parts, most notably in the "beam" or "compression" part proper—for example, the "U," the solid bar, the "channel," the angle, the "T" and so on. Each of these types taken in cross section has a distinctive value within itself and within its relation to other parts of the brake beam structure. Each of them represents the means by which inventive genius competes for superiority in meeting conditions as they evolve. Tests of these types and features are continually going on in the railway shops.

There have been strong and eminent advocates of a standard beam. The railway men as a whole have preferred to leave the opportunity open for continued improvement. Since the proposal for a standard beam was made seriously in 1910, substantial improvement has been made.

Mr. A. H. Peycke writes: "The brake beam manufacturers have conferred with the Brake Shoe and Brake Beam Committee" (of the Master Car Builders' Association) "this last year with a view to straightening out a good many points in relation to interchange dimensions, clearance conditions, etc.," and cites a report delivered before the M. C. B. convention in Atlantic City in 1919 by Mr. B. B. Milner, of the New York Central, suggesting changes which are necessary; also giving a complete synopsis of the brake beam situation since about 1905. Mr. Peycke's opinion is that "The standardization of brake beams would be decidedly disadvantageous to the railroads and people of the country, and any attempt to adopt a standard beam would suppress initiative, invention, genius and progress."

Mr. Albert Waycott observes: "Seven or eight different types of brake beams, all interchangeable on equipment in service and all meeting the M. C. B. tests, will surely illustrate how both improvement and competition might easily have been greatly reduced had any one 'type' been insisted upon."

The manifest need today, according to Mr. C. Haines Williams, "is a more strict enforcement of existing M. C. B. rules and more rigid application of test and manufacturing requirements. . . . No single design of beam has advantages sufficient to compensate for the penalty of having brake beams stand still for years. . . . The initiative and unhampered genius that produced the brake beam and brake transmission rigging that has always satisfactorily controlled our high speed trains cannot with safety be destroyed. . . . The success of past practice guarantees proper care of future problems if not interfered with by standardization, which would unquestionably develop indifference on the part of the interested brake beam manufacturers of today. All the present M. C. B. rules, specifications, requirements and safeguards have come, without exception, from the recommendations and practices of brake beam manufacturers."

Whatever may be the future of voluntary standardization, it is our conviction that the best interest of the public lies in leaving the railways free without any government participation in the process.

An important consideration cognate to this view in every line of railway requirements is that of centralized buying. Standardization would, we fear, do more than put a stop to the maintenance of vigorous departments of the manufacturing establishments for the testing and development of new devices and features. Not only would all the companies be reduced, so to speak, to automata filling orders to specifications, but there would be the further tendency to concentration of purchasing in some central bureau. Its responsible heads would probably not get and keep personal knowledge of the reliability and resources of individual makers. Bidding would tend to be controlled more and more by the element of price, and less and less by the element of quality and durability. The bureau would tend to leave in the hands of subordinates the designation of those makers permitted to bid. Inevitably this would degenerate into a stereotyped process bereft of commercial enterprise and intelligence on both sides of the counter.

What demands the future will make, who can prophesy? Mr. Charles J. Graham remarks: "Had the thought of standardization of parts been put into effect some years ago, we would still be using wooden brake beams. . . . The same is true today. There remains ample field for further improvements if they are not stifled by the fixing of standard details for parts."

We are told that locomotives and cars have reached nearly if not quite their maximum capacity; that they already crowd the overhead clearance of bridges and tunnels; that to widen the traffic gage would involve expenditures of appalling magnitude not only in acquirements of wider rights of way but in shifting and relaying existing tracks while traffic was carried on; that to lengthen the vehicles would involve us in costly track problems and complications involving station platforms and the like.

Such pessimism is a counsel of sloth. For freight transportation at least higher actual speeds may be a possibility contained in the now rapid elimination of grade crossings. To what extent will this and other tendencies toward fuller use of cars affect the stresses placed upon every part of the rolling stock? Is it certain that electric propulsion will bring no new conditions in this respect, or that fuel or other source of motive energy in the future is even yet identified? Who can affirm that the controlling factor in future transportation development is yet dreamed of in our physics and chemistry or other branch of scientific pioneering?

The manufacturer has always anticipated each new demand. When it came he was ready for it. He can exist and perform that function only if experimentation is free on the several railway systems and if achievements for the welfare of mankind promise reward to the inventor of appliances and profit to the developer.

Japanese Laborers' Wages.—The average wage for an unskilled Japanese male laborer today is 48 cents and for a female laborer 32 cents a day. A skilled laborer earns from $1.10 to $1.68 a day. These rates are about 70 per cent above pre-war rates. Besides the daily rates, however, yearly bonuses are given of a month's wages, and often considerable more. The working hours may be given generally as 70 hours per week, and the amount of work produced per hour by a Japanese workman is about one-half that produced by an average British workman where large jobs and heavy machinery are concerned.—*The Engineer.* (London.)

RAILROAD ADMINISTRATION NEWS

The number of passengers carried one mile in August was 4,375,694,522, according to the monthly report of the Operating Statistics Section. This was an increae of 8.8 per cent over August, 1918. For the eight months ending with August 31 the number of passengers carried one mile was 28,793,142,453, an increase of 6.3 per cent.

RAILROAD FACILITIES BELOW DEMAND OF TRAFFIC

The railroads of the country are now doing a heavier business for the present season of the year than was ever done in the history of the railroads in normal years, and practically as heavy business as was done at this season in 1918, which exceeded all previous records, according to a statement authorized by the director general on October 12. They have more cars in actual service, after excluding cars held out of service for repairs, than in 1917 or 1918. While the bad-order car situation was greatly embarrassed by the extensive strikes among shopmen in August, the percentage of bad-order cars is now rapidly improving. There was an increase of 52,456 cars in serviceable condition between August 16 and October 4, of which 12,110 were added in the one week ending October 4.

MILES PER CAR PER DAY INCREASING

As indicative of increased efficiency in the use of freight cars, the average mileage per freight car per day in October, 1919, was 27.3, as compared with 26.7 in September, 1919, according to a statement authorized by the director general. The comparison with October of the two preceding years is as follows:

October, 1919	27.3
October, 1918	26.0
October, 1917	25.9

The comparative progress thus made in October is even better than that made in September, as is shown by the following comparison with September of the two preceding years:

September, 1919	26.7
September, 1918	26.5
September, 1917	26.4

NUMBER OF BAD ORDER CARS BEING REDUCED

Steady and gratifying progress continues to be made in connection with the bad-order car situation, according to a statement recently authorized by the director general of railroads.

Excluding cars held out of service as not worth repairing, bad-order cars had fallen on November 15 to 130,833, or 5.2 per cent. The figures since October 4 have been listed as follows:

	No.	Per Cent
October 4	172,210	6.9
October 11	169,343	6.7
October 18	163,986	6.5
October 25	156,372	6.3
November 1	146,702	5.8
November 8	136,238	5.4
November 15	130,833	5.2

Including cars held out of service as not worth repairing, the number of bad-order cars has decreased to 150,133, or 5.9 per cent on November 15. The figures since October 4 follow:

	No.	Per Cent
October 4	191,656	7.6
October 11	188,308	7.4
October 18	183,070	7.2
October 25	175,348	7.0
November 1	166,514	6.5
November 8	155,564	6.1
November 15	150,133	5.9

TRAINMEN SEEK INTERPRETATION OF OVERTIME PROPOSAL

A committee representing the four brotherhoods of train service employees was to confer with Director General Hines on Tuesday, December 2, to ask a more specific interpretation of his recent proposal to allow time and one-half for overtime in freight service, contingent upon the elimination of all arbitraries and special allowances. The committee, which has full power to accept or reject the overtime proposal, was appointed at a conference of the general chairmen of the four brotherhoods at Cleveland, called to consider Mr. Hines' proposal, after the conference had voted to accept his offer of a held-away-from-home terminal rule providing for payment of wages for time held at other than the home terminal after 16 hours. This was as a substitute for rules proposed by the trainmen and firemen providing for pay after 10 hours. About 180 general chairmen of the firemen's brotherhood held a conference to consider what should be done in connection with their demand for a general wage increase, which has not been acted upon by the Railroad Administration.

ORDERS OF THE REGIONAL DIRECTORS

American Red Cross.—The Northwestern regional director, file 33-1-17, urges that every officer and employee be given an opportunity to take a Red Cross membership for the coming year in view of the great humanitarian work the American Red Cross has performed.

Employment of Men in Train and Engine Service.—The Northwestern regional director, file 42-1-87, requires that men entering the service to fill the position of brakemen, flagmen, baggagemen, switchmen and firemen must be able to read and write; will be required to pass uniform examination and will comply with the regulations governing the use of standard watches.

Incomplete Brakes on Gondola Cars.—Supplement 2 to Circular 201 of the Southwestern regional director states that 500 U. S. Standard hopper cars, allocated to the Pere Marquette, built by the Ralston Steel Car Company and numbered 13,000 to 13,499, were placed in service without sheave wheels on brake and hand brake pull rod. The circular instructs that where these cars are found with sheave wheels omitted on the end of the hand brake rod changes should be made at once, regardless of ownership.

Improved Car Handling.—Circular 86 of the Northwestern regional director calls attention to the necessity for the improving of car handling, especially in view of the present acute situation in connection with car supply. In addition to this, particular attention should be paid to the prompt delivery of cars to connections, early arrivals at freight houses and team track deliveries, prompt unloading of equipment and movement of "company" material utilizing the full capacity for loading, which will result in saving of much equipment for revenue loading.

SUBSTITUTE FOR PNEUMATIC TIRES.—From Christiania, Norway, Consul General Marion Letcher reports that Lieut. Col. Fridtjof Andersen, a retired Norwegian army officer, has just perfected an invention which he claims will serve a sa substitute for pneumatic tires now used on motor vehicles. The invention involves the use of steel springs tangentially applied to the wheels, with an outer rim of solid rubber, steel, wood or other material. The inventor claims that spring wheels, manufactured according to his designs, may be used on street cars and railway trains, as well as on lighter vehicles. No arrangements have as yet been made for the manufacture of spring wheels.—*Manufacturers News.*

CAR DEPARTMENT

INSULATING TRAIN STEAM PIPES

BY W. N. ALLMAN

THE subject of fuel conservation has been one of considerable discussion during the past few years and at the present time is a matter of paramount importance. The conservation of fuel should therefore not be treated lightly and every phase of the subject should be carefully studied and investigated. There has been much literature published by the various departments of the government, treating the subject in a most complete manner and it is now acknowledged by all to be a vital factor and therefore must not be neglected even to the smallest detail.

In the operation of passenger train equipment there is considerable exposure of the train steam heat line. The radiating surface on an 80-ft. line for a 10-car train would be 500 sq. ft., and there would be a large loss in heat units if this surface was not adequately protected by some efficient form of insulation.

There are a number of types of insulation on the market to-day which may be generally grouped under the laminated type, the moulded type and the cellular type. Primarily, the load is placed on the locomotive and by reducing the amount of steam required to a minimum the saving in dollars and cents is realized.

The problem is to carry the heat to destination—interior of the cars—with the least amount of loss, and this can only be done by properly insulating the train steam pipes. It should also be understood that the efficiency of all insulations varies according to the size of the pipe to which it is applied; according to the temperature of steam in the pipes and the temperature of the surrounding air; another factor is the thickness of the insulation.

The efficiency of pipe covering is the per cent saving which would be obtained by insulating that pipe with a certain material over what would be lost if the pipe were left bare or uninsulated.

This per cent is obtained by subtracting the heat loss of the insulated pipe from that of the bare pipe and dividing the difference by the heat loss from the bare pipe. Expressed as a formula this would then be:

$$E = \frac{A - B}{A}$$

where

E = Efficiency

A = Heat loss through bare pipe.

B = Heat loss through insulated pipe.

The heat losses may therefore be compared directly as follows:

Bare pipes ....100 per cent
Efficiency ....percent saving
100 per cent—per cent efficiency = loss through insulation expressed as a percentage of bare pipes.

For example, an insulation having an efficiency of 86 per cent allows a loss of only 14 per cent of the loss from bare pipes.

TYPES OF COVERINGS

Not all pipe coverings can be termed good insulation, some being efficient at low pressures, but very inefficient at higher pressures. Some coverings are fairly efficient when first applied but soon deteriorate and do not maintain their efficiency, while others maintain their initial efficiency indefinitely. The underlying principle of efficient insulation is confined to dead air cells, and perhaps one of the best forms of pipe covering is that of the laminated type, which consists of a number of layers of felt composed of asbestos fibre and particles of finely ground spongy material, this combination forming an extremely cellular felt. These layers of felt, being built up in laminated form, confine a large volume of minute dead air cells between the layers, and the general construction makes it a highly efficient covering and one that is most durable as well as maintaining its efficiency indefinitely.

The next best form, perhaps, is the moulded type of insulation, known as magnesia, and which is a light highly efficient insulation. In this type of covering there is also a large number of miscroscopically small dead air cells. These dead air cells cause the air to become stagnant, and thus a very poor conductor, thereby increasing the efficiency. This form of covering, however, is not as adaptable to service on train pipes as is the laminated form, because of the constant vibration which is more or less detrimental to this form of covering. The cellular type would then be considered the next best class of covering for train service and it may be of interest to note the saving that may be realized from the following analysis, which is based on pipe covering one inch thick in each instance, this being the thickness now generally recognized to be the most efficient for train service.

SAVING DUE TO INSULATION

In making this comparison three types of pipe insulation are used, having a known efficiency, and for the sake of convenience they will be designated as *A*, *B* and *C* coverings —all one inch thick.

A = Laminated form.

B = Cellular type, corrugations running around the pipe, not parallel with pipe.

C = Larger form with indentations in layers.

The efficiency of these coverings for a two-inch pipe and for the temperature difference dealt with hereafter, are as follows:

A = 85.84 per cent.

B = 82.00 per cent.

C = 78.60 per cent.

For our investigation we will consider a 10-car train, each car having 80 ft. of two-inch pipe, which is equivalent to 500 sq. ft. of radiating surface. Train line pressure 50 lb., outside temperature 20 deg. F. above zero. The results are calculated as follows:

Temperature of steam in train line at 50 lb. pressure	334.3 deg.
Outside temperature	20.0 deg.
Temperature difference	314.3 deg.

Loss in B.t.u.'s per hour, per sq. ft. bare pipe...	1,070.0
Total radiating surface, sq. ft.	500
Total loss in B.t.u.'s per hour	535,000
Hours of service per day	16
Total loss in B.t.u.'s per day	8,560,000

Assuming coal to have a thermal content of 10,000 B.t.u.'s, this would be equivalent to 856 lb. of coal per day loss, or at four dollars per ton $\frac{4.00}{2{,}000} = .002 \times 856 = \$1{,}712$ loss per day from bare pipes.

The saving per day effected by using the three types of covering which have been described would be as follows:

Type of covering	Efficiency	Saving per day
A	85.84 per cent	$1.47
B	82.00 per cent	1.40
C	78.60 per cent	1.35

The initial cost of the covering would soon pay for itself and the saving of wasted heat units and ultimate dollars and cents would soon amount to a considerable item. The temperature of steam in train line of 334.3 deg. F, as covered in the above analysis, is obtained from the following formula:

Temperature of steam (saturated) at boiler pressure of 200 lb. per sq. in.	388 deg. F.
Total heat in saturated steam at 200 lb. per sq. in.	1,199.2 B.t.u.
Total heat in saturated steam at 50 lb. per sq. in.	1,178.5 B.t.u.
	20.7 B.t.u.

Since change through reducing valve has been a constant heat change, that is, no work done and no heat gained or lost, the heat in steam at 50 lb. per sq. in. above normal saturation content must be in the form of superheat. Therefore:

$$H_t = S\,(T_s - T_n)$$

Where:

H_t = Total heat above saturation heat content
S = Specific heat of superheated steam
T_s = Highest temperature of superheat
T_n = Normal temperature of steam at pressure given.

Therefore:

$$H_t = 20.7 \qquad S = .57$$

$$20.7 = .57\,(T_s - T_n)$$

$$\text{or } (T_s - T_n) = \frac{20.7}{.57} = 36.3$$

$$T_n = 298.0$$

$$\text{or } T_s = 298.0 + 36.3 = 334.3$$

The above conditions and analysis may be considered normal, and results would vary with temperature conditions. For example, in certain sections of the country during the winter the temperature would be much lower than that considered above, also, as the velocity of train increases the loss is greater and as the foregoing is based entirely on still air conditions, the saving would be even greater and more so by using the best insulation or that having the highest efficiency.

The following table will be convenient for determining the heat loss in B.t.u.'s from bare pipes:

TOTAL HEAT LOSS IN B. T. U.'S PER HOUR PER LINEAL FOOT OF BASE PIPE OF DIFFERENT SIZES AND AT VARIOUS TEMPERATURE DIFFERENCES AS GIVEN BELOW

Pipe Size	Area of Pipe Surface per lin. ft.	50 Deg.	100 Deg.	150 Deg.	200 Deg.	250 Deg.	300 Deg.	350 Deg.	400 Deg.	450 Deg.	500
½-inch	.220	21.5	47.3	79.2	117.3	162.3	215.2	279.1	355.1	451.4	569.8
¾-inch	.274	26.8	59.0	98.6	146.8	202.1	268.5	347.6	442.2	562.2	709.7
1 -inch	.344	33.6	74.0	123.8	183.4	253.7	337.4	436.5	555.2	705.4	891
1¼-inch	.435	42.5	93.6	156.6	231.9	320.8	425.4	551.9	702.1	892.6	1126.7
1½-inch	.498	48.7	107.2	179.3	265.4	367.3	487	631.8	803.8	1021.9	1289.8
2 -inch	.622	60.9	133.9	331.5	331.5	458.7	608.3	789.2	1003.9	1276.3	1611
2½-inch	7.51	73.4	161.6	270.4	400.3	553.9	734.5	952.8	1212.1	1541.1	1945.1
3 -inch	.917	89.6	197.3	330.1	488.8	676.3	896.8	1163.4	1480	1881.7	2375
3½-inch	1.047	102.3	225.3	376.9	558.1	772.2	1024	1328.4	1689.9	2148.4	2711.7
4 -inch	1.178	115.1	253.5	424.2	627.9	868.8	1152.1	1494.6	1901.3	2417.3	3051
4½-inch	1.308	127.9	281.5	470.9	697.2	964.7	1279.2	1659.5	2111.1	2684	3387.7
5 -inch	1.455	142.2	313.1	523.8	775.5	1073	1423	1846	2348.4	2985.7	3768.5
6 -inch	1.733	169.4	371.9	623.9	923.7	1278.1	1694.9	2198.7	2797.1	3556.2	4488.5
8 -inch	2.257	220.6	485.7	812.5	1203	1664.5	2207.3	2863.6	3642.8	4631.4	5845.6
10 -inch	2.817	275.4	606.2	1014.1	1501.5	2077.5	2755	3574.1	4546.6	5780.5	7296
The following losses apply to flat as well as curved cylindrical surfaces:											
B. t. u. Loss per sq. ft. per hour		97.5	215.2	360.0	533.0	737.8	978.0	1269.4	1614.0	2050.6	2590.0
Ditto per degree temp. difference		1.950	2.152	2.400	2.665	2.951	3.260	3.627	4.035	4.557	5.180

NOTE: For other temperatures than those shown in the table, the heat losses can be determined by interpolation.

Locotractors in South Africa.—A contemporary states that owing to the high cost of operating the usual forms of motor truck in South Africa, a modification of the truck tractor is being used. Roads are very poor and during the rainy season are often impassable. The light railway is advocated as the solution and suitable motive power is believed to have been definitely discovered in a gasoline locotractor, a special form of machine intended to take the place of the locomotive on pioneer light railways. The locotraction system uses load-carrying cars running wholly upon rails. The guiding portion of the locotractor also runs on the rails, but the driving wheels, shod with solid rubber tires, run on prepared strips of road metal on each side of the railway track and have greater traction. For a given horsepower and weight the hauling power is stated to be four times as great as with ordinary locomotives having driving wheels running on tracks.

Wood Fuel on Swiss Railways.—*The Times Trade Supplement* states that the results obtained from the use of wood fuel in Switzerland are of considerable interest. The technical difficulties were not so great as was anticipated. On lighting the fires with one cubic meter of wood a steam pressure of from five to six atmospheres was obtained in 1½ hours, for which otherwise 300 kilos of coal would have been required. The cost was approximately $13 (pre-war rate), as against approximately $15 (pre-war rate) with coal. The same maximum driving rates were obtained as with coal. The difficulty of storing fuel for long journeys was met by running a special truck behind the engine.

REFRIGERATOR CARS FOR THE C. P. R.

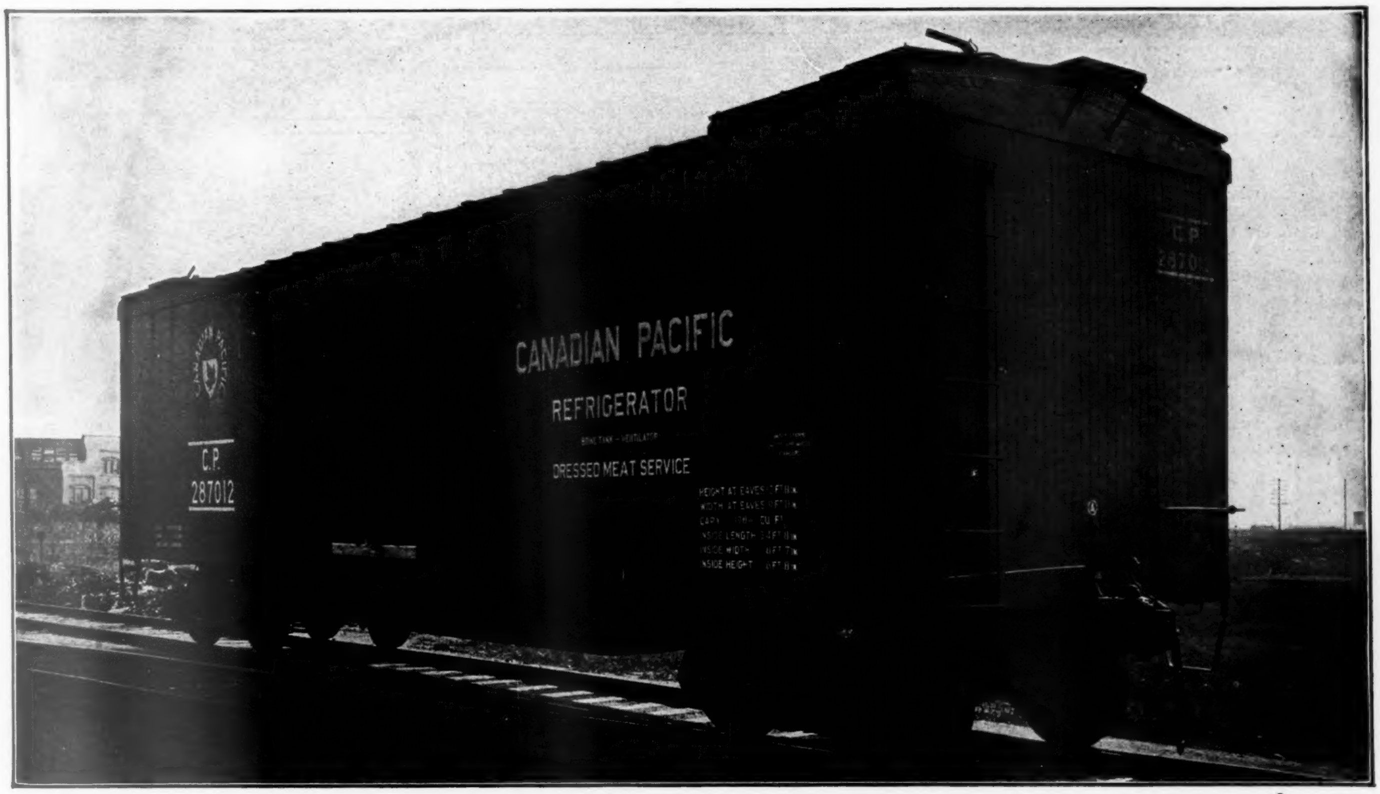
Steel Underframe Construction, 41 ft. Long, Fitted with Tank Bunkers, Meat Racks and Ventilators

The Canadian Pacific has recently built at its Angus shops, Montreal, an order of steel underframe refrigerator cars, which embody a number of interesting features, both in the underframe and body construction as well as in the refrigerating equipment. The cars are designed for satisfactory service when handling any of the several different commodities which require transportation in insulated cars because of the need of protection from heat or frost, and also for other miscellaneous freight which may properly be loaded in refrigerator cars when they are not required for the transportation of perishables.

As packing house products are regularly handled in Canada by railroad owned refrigerators, these cars are equipped with galvanized iron tank bunkers which permit the use of salt as required to obtain the proper degree of temperature. To prevent the exchange of air through the hatch openings at any time, and especially when the hatches are opened for re-icing, the tanks fit well around the ceiling. Regulation meat racks are included as part of the roof and ceiling construction.

For berry and fruit traffic it is necessary to provide a means of ventilation. This has been taken care of by providing openings in the fronts of the ice tanks near the top, so that when the hatch covers and plugs are opened, air will circulate freely into and through the car. The ventilator openings are fitted with malleable iron frames and close-fitting plate slides, which are secured in a closed position at all times except when the cars are operating under ventilation.

The use of ice or ice and salt when operating under ventilation, is optional, thus providing a wide range of regulation which may be varied to suit the seasons, conditions of the load, and the distance to be moved. Fruit fresh from the field is a very difficult commodity to transport, as the field heat and heat generated by the ripening process produces a condition that is difficult to handle. However, the brine tank ventilator car when equipped with suitable floor racks arranged so that free circulation will take place around the ice and out under the racks, is particularly suited to this traffic, as the use of salt on the initial icing lowers the temperature of the car rapidly, absorbing the field heat and checking the process of ripening. For fruit shipments it is well to apply temporary slats along the sides of the car to provide space for circulation at the sides as well as underneath. All other perishables may easily be transported safely in these cars, provided reasonable care is used in leading so that the air within the car may circulate freely.



Steel Underframe Refrigerator Car with Brine Tanks and Ventilators, for the Canadian Pacific

Whenever the lading requires protection from frost, charcoal heaters are placed in the corner ice tanks, two or more per car, as required.

THE REFRIGERATING EQUIPMENT

Permanent floor racks made of 1¾-in. by 3¾-in. fir are installed in sections, five sections on each side of the car. They are secured with hinges, similar to those used on side doors, to the lining base plank, and when propped up against the car sides, the racks are entirely clear of the floor, thus permitting the floor to be thoroughly and easily cleaned and swept out through the side door openings. The racks are made of relatively heavy material to insure durability, especially when the car is loaded with general freight.

The ice bunkers consist of four rectangular galvanized iron

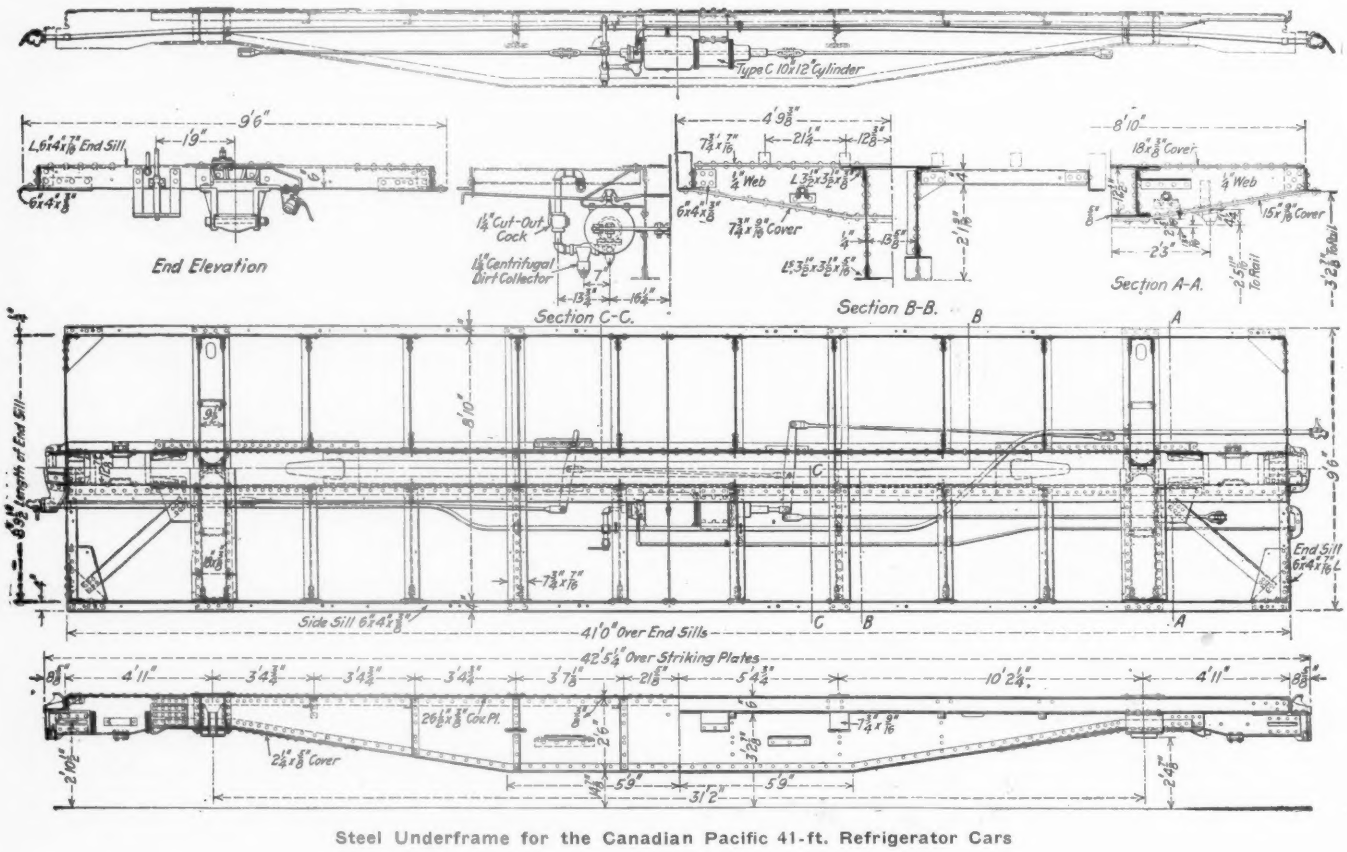
tanks at each end of the car; the tank bottoms are 1/8-in. pressed steel, galvanized after pressing, and the sides are 16-gage galvanized iron. Substantial lugs are riveted near the top. These lugs bear against the underside of the hatch frame and prevent the tanks from jumping when the cars are being switched. The tank supports consist of angle irons which are arranged so that the front supporting angle may be removed without disturbing any tank. After the removal of this angle one or more tanks may be removed and reapplied without disturbing the others.

The drip pan under the tank is sloped from the rear end towards the front of the tank, so as to be as nearly self-clearing as possible. The front edge of the drip pan is made of 1/8-in. pressed steel plate, galvanized. This arrangement avoids, to a considerable degree, the obstruction of free circulation of air down around the tanks and out under the floor racks.

Only the center tanks at the ladder corners are equipped to the edge of the center sill cover plate, while the intermediate stringers rest on and are bolted to the bolsters, cross-bearers and floor beams. Between the stringers four layers of 1/2-in. insulation are applied in strips, continuous from end to end of the car. Each layer consists of hair or fibre felt stitched between two courses of 90-lb. waterproof insulation paper. The four layers are applied in two courses of double layers, with nailing strips and 3/8-in. tongued and grooved boards between.

The floor consists of two courses of tongued and grooved boards, the under course 5/8 in. thick, over which is spread a heavy coating of hot, waterproof asphalt, and over this one layer of two-ply asphaltum roofing paper. The top course boards are 1 1/8 in thick.

The side and end walls are insulated with three layers of 1/2-in. insulating material, each layer stitched between two layers of 90-lb. waterproof insulation paper. Side and end walls insulation extends continuously from floor to ceiling



Steel Underframe for the Canadian Pacific 41-ft. Refrigerator Cars

with a drain valve. The remaining three tanks at each end of the car are coupled to this tank by hose connections located two feet above the tank bottom. The drain valve is connected to a pipe extending directly through the car floor.

Insulated bulkheads are provided in front of the ice bunkers. These bulkheads are hinged at one side of the car so that they may easily be swung open for inspection, cleaning or repairing the tanks. These bulkheads have an extension at the bottom with horizontal slats to prevent small crates or boxes from sliding under the bulkhead.

The ice hatches are of U. S. R. A. design, modified only as absolutely necessary to suit conditions.

INSULATION

The floor insulation consists of one layer of 90-lb. waterproof insulation paper applied in one piece from side to side and end to end of the car, thereby covering the entire underframe and sub-floor. On top of this are placed the floor stringers. The center stringers rest on and are bolted and from the door opening to the end of the car, across the end and to the door post opposite the starting point. One layer of the insulation is applied on the outside of the superstructure frame, overlapping and fastened to the sills and plates. Two courses are applied on the inside of the framing, against the 3/8-in. tongued and grooved sheathing. The outside sheathing consists of standard 13/16-in. tongued and grooved car sheathing and the inside lining is 13/16-in. tongued and grooved basswood or spruce. The total thickness through the side walls is 6 1/2 in.

The roof insulation consists of six layers of 1/2-in. insulating material, each layer stitched between two courses of 90-lb. waterproof insulation paper. The insulation is applied in one piece between the carlines from side plate to side plate. It is applied in three double layers, each double layer supported on 3/8-in. tongued and grooved boards.

On the top side of the ceiling boards one layer of 90-lb. waterproof insulation paper is applied in one piece from side to side and end to end of the car.

SUPERSTRUCTURE FRAME

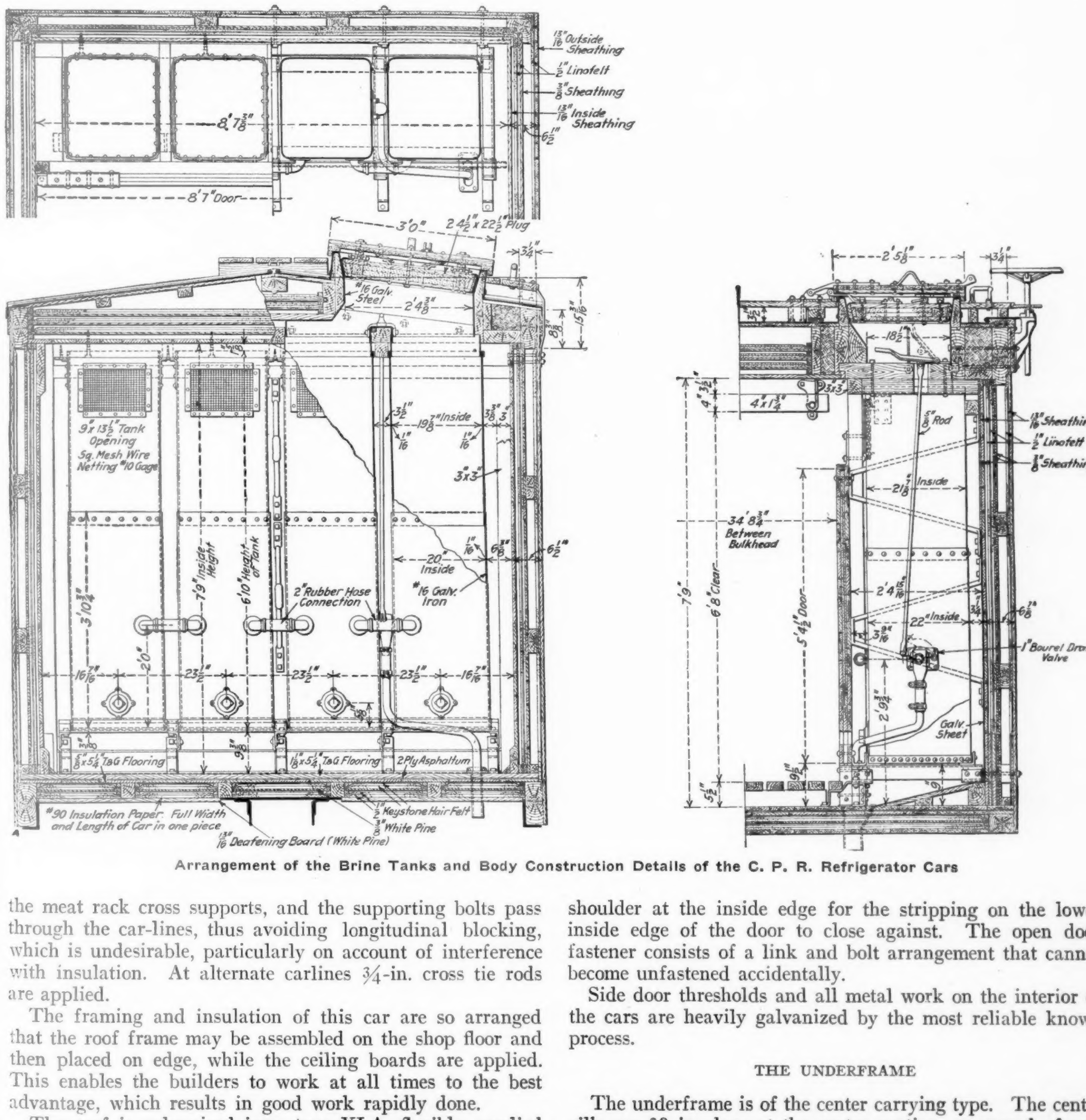
The principal framing members of the car body are fir, excepting end sills, end posts and end braces, which are of oak or maple. All of the posts and braces are set in cast iron pockets with the exception of the end post and braces, which are set in special cast steel pockets, each having a high flange on the outside to prevent the lower ends of the posts and braces from springing over the top of the casting. Each casting is bolted directly through the steel end sill flange with two 5/8-in. bolts. This is to prevent the pocket from tipping out and also to avoid trouble caused by dowels splitting the wood end sill.

Diagonal brace rods are employed at each side frame panel to reduce racking to a minimum.

The spacing of the carlines coincides with the spacing of carlines is governed by the spacing of the meat rack supports and on account of the roof insulation the roof mullions and running board saddles are spaced to coincide with the carline centers; this provides a solid construction for nailing the mullions.

The roof sheet pivot saddles are secured by carriage bolts applied through a special washer nailed on the underside of the ridge pole; this washer when applied is L-shaped and is secured by two nails. After the carriage bolt has been applied the projecting end of the washer is bent back under the bolt head to prevent the bolt from dropping down. The hole in the washer is square, to suit the shank in the bolt head.

The side doors are equipped with W. H. Miner fasteners. The threshold plates are of pressed steel with a shallow



Arrangement of the Brine Tanks and Body Construction Details of the C. P. R. Refrigerator Cars

the meat rack cross supports, and the supporting bolts pass through the car-lines, thus avoiding longitudinal blocking, which is undesirable, particularly on account of interference with insulation. At alternate carlines 3/4-in. cross tie rods are applied.

The framing and insulation of this car are so arranged that the roof frame may be assembled on the shop floor and then placed on edge, while the ceiling boards are applied. This enables the builders to work at all times to the best advantage, which results in good work rapidly done.

The roof is galvanized iron, type XLA, flexible, applied over a single course of boards and one layer of two-ply asphaltum roof paper. As already noted, the spacing of the shoulder at the inside edge for the stripping on the lower inside edge of the door to close against. The open door fastener consists of a link and bolt arrangement that cannot become unfastened accidentally.

Side door thresholds and all metal work on the interior of the cars are heavily galvanized by the most reliable known process.

THE UNDERFRAME

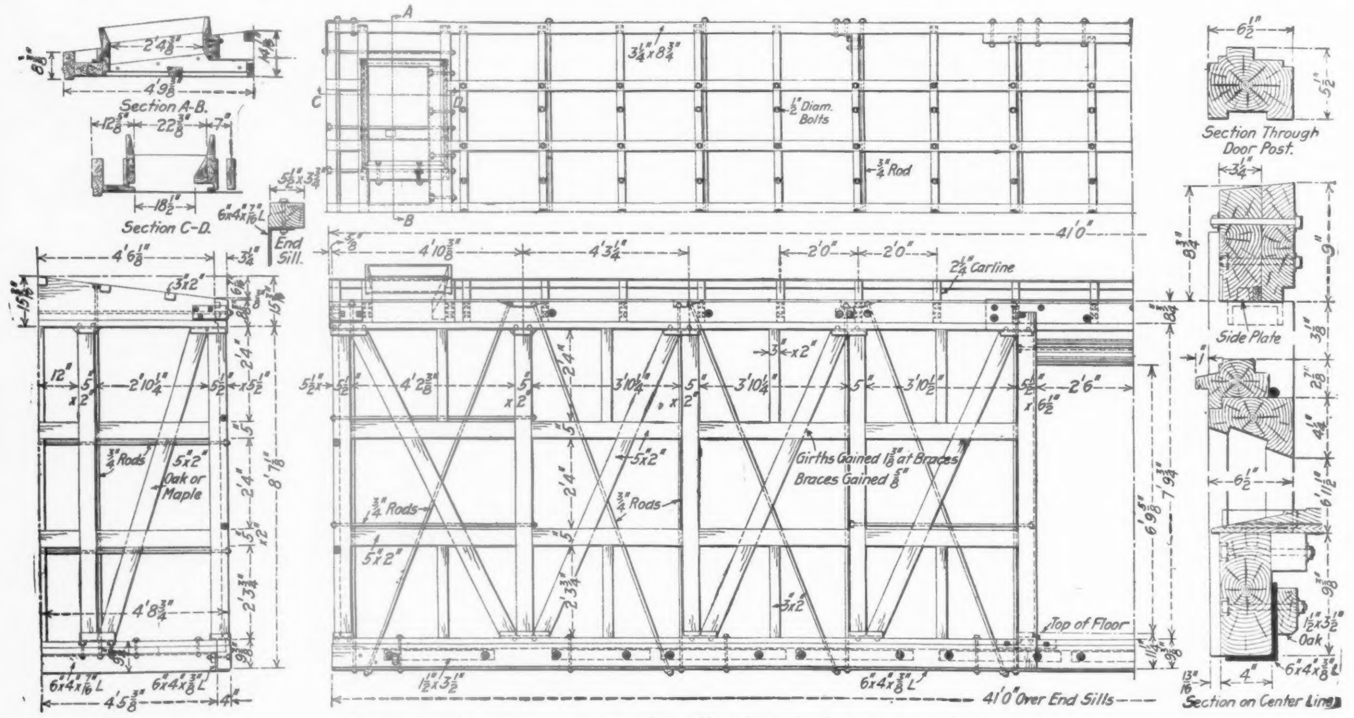
The underframe is of the center carrying type. The center sills are 30 in. deep at the center portion, composed of web plates 1/4-in. thick, a 3/8-in. by 26 1/2-in. top cover plate continuous one piece from end to end of the car, top flange

angles of 3½-in. by 3½-in. by ⅜-in. section, and 3½-in. by 3½-in. by 5/16-in. bottom flange angles. The center sill bottom cover is of ⅝-in. by 21¼-in. plate.

The bolsters are of the box girder type, composed of ¼-in. pressed steel diaphragms, with a ⅜-in. top cover plate, 18 in. wide, and a 9/16-in. bottom cover plate, 15 in. wide. The crossbearers are of single web girder construction, consisting of ¼-in. pressed steel diaphragms, with a 7/16-in. by 7¾-in. top cover and a 9/16-in. by 7¾-in. bottom cover. The floor beams are 4-in., 8.2-lb. Z-bars, and the side sills are 6-in. by 4-in. by ⅜-in. angles. The end sill angles are of 6-in. by 4-in. by 7/16-in. section.

The draft arms are of ⅜-in. pressed steel. The rear draft lugs are secured to the draft arm and center sill splice, and are also riveted to the center sill bottom cover. The front draft lugs are designed to receive a cast steel coupler striking plate and cast steel carry iron; the latter is secured by a 1⅜-in. bolt passing through the lower front corners of the draft lugs. The cast steel striking plate has an extension arm for the angle cock bracket, so arranged that the bracket may be located correctly for 9¼-in. or 12-in. coupler heads.

The cars are equipped with friction draft gear, cast steel yokes and 5-in. by 1⅛-in. coupler yoke keys.



Superstructure Frame of the Canadian Pacific Refrigerator Cars

TRUCKS

The cars are equipped with C. P. R. standard 40-ton arch bar type trucks, having Simplex bolsters designed to support the center pin in the truck bolster. The truck columns are of the Harrigan pinless brake hanger bracket type. Side bearings are of the roller type located 27-in. from the car center.

Adjustment of brake piston travel is provided for on the floating lever fulcrum, making it unnecessary to change the adjustment on the trucks after they have been correctly adjusted when the car is built, except that variations in the dimensions of brake beams and rods applied in renewals may require the truck levers to be readjusted.

The brake mast is 1¼-in. square and is fitted with a snow and ice proof ratchet and dog.

The tare weights of these cars average between 59,000 and 60,000 lb., resulting in a limit load capacity, including ice, of 72,000 to 73,000 lb.

SOME CAUSES OF HOT BOXES*

BY S. W. CRAWFORD
President, More Jones Brass Company, St. Louis, Mo.

The M. C. B. type of journal bearing used in railroad cars has been standard for a great many years, although there have been many efforts to develop other types to substitute it. The first bearings were made of solid bronze, and the first linings used in bearings were made by sweating in a sheet of lead, which was done to overcome the variation in size of journals due to wear. The solid bronze bearing, when applied, would not fit the journal and consequently, it would frequently cause trouble until it was worn down to a journal fit. The thin sheet lead lining was a decided improvement on the solid bronze, as it would give under the load and fit the journal, but as it was very thin, it only provided a starter for the bearing, following which the lining was increased in thickness, by making the lining of babbitt metal, until we finally developed the filled type of bearing, which was a bronze shell, filled with babbitt.

As the lining thickness was increased the babbitt was made comparatively harder, so it would withstand the load. This provided a cheaper bearing, but they have been universally discarded for the reason they were not capable of withstanding the same load or strain as the solid bearing and as a result, caused a great many hot boxes.

A classification of bearings was provided by the M. C. B. Association for filled journal bearing linings ⅜ in. or over in thickness; solid bearings having lining less than ⅜ in. thickness.

A reaction took place. As the use of hard babbitt had been developed, and the thickness of the lining gradually reduced without reducing the hardness of lining, many hot boxes were the result. Bearings would not fit themselves to the journals with the bearing area so small. If the load is too great for the surface area of bearing, the filament of lubrication will break, and a hot bearing will be the result.

I had a case on a road, where they had been using filled

*From a paper read before the St. Louis Car Foremen's Association.

journals bearings for years, and decided, due to the fact that they had very carefully figured over the cost on solid bearings, as compared to filled bearings, to adopt the use of solid bearings, with ¼ in. thickness of lining. The road had specifications, and the lining metal they had been using was what we call an 18 per cent lining, a good one in a filled bearing. But as the thickness of lining had been reduced, the lining metal proved to be too hard and resulted in a great many hot boxes. I was called on to investigate these conditions, and found in some cases as many as a dozen bearings to have been applied to one pair of wheels, all of which were removed before they had fitted themselves to the journal. A conference was called of the car men, and as the universal opinion was that the lining was too hard, we suggested a change, reducing to 10 per cent. As this was quite a big reduction in the degree of hardness, it raised the question as to whether we would shorten the life of the bearing from a wearing standpoint. Quite the opposite proved to be the case, as the bearings lasted longer, and as a result, we today exercise as a standard, the 10 per cent lining, unless the specification of the railroad is otherwise.

I believe our hot box troubles are less than at any time I have ever known, but there is no doubt room for further improvement. We can build up better efficiency in bearings as we do in everything else, by close co-operation. We are doing in the brass business now what we did not think of years ago, and that is to get out on the road with the men using these bearings, studying their side of the situation, and studying conditions under which they are operating.

If we are going to get best results, we must establish the best practice, not at one point, but at all points. Men must be made familiar with the material they are using—not only the bearings, to see that they properly fit the wedge and journal, but they must know that the waste, etc., which they are using is of a quality to furnish the lubrication for that bearing. I have found cases, which showed, upon examination, that the oil from the waste in the oil box would only feed out of the packing one-half to one inch in depth. The remainder of the packing in the box had a great quantity of oil, sufficient to lubricate for a long time, but it could not get to the journal. That was due to the fact that the waste was not of a quality to feed the lubrication. You can have a lamp full of oil, but produce a poor light, because the wick is not of a quality that will feed the proper amount of oil to produce the light. The same applies in the oil box with the waste, which is the wick.

Generally, wherever you find cracked linings in journal bearings, you will find very careful inspection. The cracked lining is caused where the bearing is not getting enough lubrication. The temperature reaches a point where it fuses the solder which holds the lining in the bearing at about 400 deg. F. The fusing temperature of the lining is about 500 deg. As there is 100 deg. difference between the fusing point of the solder, which holds the lining in the bearing, when the temperature reaches the fusing point of the solder, it will loosen the lining. Then, if the bearing is given attention, and you re-establish the proper lubrication, the bearing will cool down, and when it is cooled down, that portion unsoldered remains loose. The result is, the vibration of the loose lining running over frogs and crossings, causes it to crack. That is why I say, wherever you find cracked linings, the road is giving close inspection to the cars. If it did not, instead of having cracked linings, the babbitt would have been melted out.

A great many hot boxes are brought about through some carelessness in applying bearings, such as allowing waste or dirt to get between the journal and the bearing. If it does, it will almost always produce a hot box, because it will stop the flow of lubricant, and cause the bearings to pinch. The waste between the bearing and journal will burn and carbonize, in which case it will make a very hard spot, and cut the journal. We have a great many times received complaints regarding hard spots in the lining. The hard spots are usually caused by the filament of lubrication being broken, and allowing the lining metal to come in contact with the axle, which will burnish it, and make a bright spot in the bearing. That spot is no harder under the polished surface than the other metal, because we cannot produce a lining metal harder in one part of a bearing than in the other. If a spot is burnished in a journal bearing, it takes on a very bright, smooth surface, like glass, and the oil will not lubricate under the polished surface. If the spot is removed by scraping, the bearing can safely be reapplied.

I have found a lot of cases where journal bearing wedges did not have the proper clearance on the bevels of the brass, and in some cases the wedges extended down so that they formed a bearing on the lower edge or lugs of the brass. This would cause the brass to pinch on the journal, resulting in hot boxes. Under no circumstances should wedges be a tight fit on journal bearings.

If we get together and work for a standard practice, we can get results that would probably mean eliminating the necessity of sending men along with a pair of wheels when applying new bearings, which is the practice on some railroads, and not on others. I can see no good reason why it should be necessary to send men along with a pair of wheels, to see that bearings will run, if the care is exercised to see that the bearings fit properly in wedges, box and journal, and the proper packing and lubrication is applied.

METHOD OF DETERMINING THE MOISTURE CONTENT OF WOOD

The moisture content of lumber gives a good indication of the amount of shrinkage which may be expected to take place during seasoning. For that reason many railroads specify the maximum percentage of moisture permissible in lumber for freight cars, particularly in single sheathed cars. The following directions for determining the moisture content of wood, issued by the Forest Products Laboratory of the United States Forest Service, are therefore of interest.

FIVE STEPS IN MAKING A MOISTURE DETERMINATION

(1) Select a representative sample of the material. (2) Immediately after sawing, remove all loose splinters and weigh the sample. (3) Put the sample in an oven maintained at a temperature of 212 deg. F. (100 deg. C.) and dry until constant weight is attained. (4) Reweigh the sample to obtain the oven-dry weight. (5) Divide the loss in weight by the oven-dry weight and multiply the result by 100 to get the percentage of moisture in the original sample. Thus,

$$\text{Percentage moisture} = \frac{(W-D)}{D} 100$$

where

W = Original weight as found under 2 above
D = Oven-dry weight as found under 4 above.

Selection of the Sample.—If possible, the sample should be taken from near the center of the piece. Wood gives off or takes on moisture more rapidly from the end grain than from the side grain and as a result there may be considerable difference between the moisture content of the ends and center of a stick. For this reason a sample from within about a foot of the end of a long board may not be representative. Short pieces of wood dry out much more rapidly than longer ones. In order to reduce the time required for drying, therefore, the length of the sample in the direction of the grain should usually be about one inch. With ma-

terial one square inch or less in cross-sectional area, however, a sample over one inch long is generally desirable and the length in this case may be chosen so as to give the sample a volume of two or more cubic inches. The other dimensions may be equal to the cross section of the board from which the sample is taken.

Weighing.—It is important that the weight be taken immediately after the sample is cut, for the material is subject to moisture changes on exposure to the air. The degree and rapidity of change are dependent on the moisture content of the piece and the air conditions to which it is exposed. In order to insure good results the weights should be correct to within at least one-half of one per cent.

Drying.—When placed in the oven for drying, the samples should be open piled to allow free access of air to each piece. The oven should have some ventilation, thus allowing the evaporated moisture to escape. A thermometer should be provided by which the temperature can be ascertained at any time. The temperature should at no time exceed the boiling point of water (212 deg. F.) or distillation of the wood may take place, and erroneous results be secured. From 24 to 96 hrs. of oven drying may be required for the sample to reach a constant weight, depending on the size and kind of wood and the amount of moisture it contains.

Reweighing.—As in the case of the first weight taken, it is essential that the sample be weighed soon after being removed from the oven.

A typical example of the computation necessary for determining the percentage of moisture is given below: A 2-in. by 2-in. by 1-in. sample of air-dry Sitka spruce weighed 30.8 grams. The sample after oven-drying weighed 27.5 grams. Find the moisture content of the sample.

$$\text{Percentage moisture} = \frac{(30.8 - 27.5)}{27.5} 100 = \frac{330}{27.5} = 12.$$

HANDLING EQUIPMENT WITH DEFECTIVE SAFETY APPLIANCES

BY M. J. LACOURT
District General Car Foreman, Chicago, Milwaukee & St. Paul

Railroad officers often place wrong interpretations on the handling of equipment having penalty safety appliance defects. Reportable safety appliance defects should not be confused with penalty defects. A car having a reportable defect may be moved in trains; a car having a penalty defect cannot be moved except for the purpose of repairs when repairs cannot be made where the car is found defective, and the movement must be to the nearest point where repairs can be made. The car must not be otherwise used between stations or yards.

Any movement of a car having a penalty defect was held to be a violation of the law as originally passed. However, it was practically impossible to enforce this act and Congress in adopting the amendment of 1910 undoubtedly had this in mind. The following is a verbatim extract of the section of the Safety Appliance Act bearing on this subject:

Section 4.—That any common carrier subject to this Act using, hauling or permitting to be used or hauled on its line any car subject to the requirements of this Act not equipped as provided in this Act shall be liable to a penalty of one hundred dollars for each and every such violation, to be recovered as provided in Section six of the Act of March second, eighteen hundred and ninety-three; as amended April first, eighteen hundred ninety-six; PROVIDED: That where any car shall have been properly equipped, as provided in this Act and the other Acts mentioned herein, and such equipment shall have become defective or insecure while such car was being used by such carrier upon its line of railroad, such car may be hauled from the place where such equipment was first discovered to be defective or insecure to the nearest available point where such car can be repaired, without liability for the penalties imposed by Section four of this Act or Section six of the Act of March second, eighteen hundred and ninety-three, as amended by the Act of April first, eighteen hundred and ninety-six, if such movement is necessary to make such repairs and such hauling of such car shall be at the sole risk of the carrier, and nothing in this section shall be construed to relieve such carrier from liability in any remedial action for the death or injury of any railroad employee, caused to such employee by reason of or in connection with the movement or hauling of such car with equipment which is defective or insecure, or which is not maintained in accordance with the requirements of this Act and the other Acts herein referred to; and nothing in this proviso shall be construed to permit the hauling of defective cars by means of chains instead of drawbars, in revenue trains or in association with other cars that are commercially used, unless such defective cars contain live stock or "perishable freight."

In applying the act care and good judgment must be used in interpreting it as to the nature or extent of the damage which a car must carry in order to permit of moving it to a shop. The place where the car is located should be considered as well as the nature of the defect. By moving the necessary facilities and material to the car any defect could be repaired. If necessary, a car could be built at any outlying point, but that is not the intent of the law. The law should be interpreted to mean that a car found defective at a point where the road does not maintain the necessary facilities and men, undoubtedly could be moved for the purpose of repairs to the nearest available point where that class of repairs is ordinarily made. In choosing between two points where the class of work intended might be handled, one point may be a little nearer, but the other point more readily available, due to the fact that the car could be moved to this point by one train movement, whereas the nearest point may require the switching of the car at some terminal point. In such cases the most available point would be the proper point to which to haul the car for repairs.

The law requires that a car which becomes defective while being used by the railroad should be repaired where the car is first discovered, thus avoiding injury to switchmen and others who are required to move the car in case it is to be moved for the purpose of repairs. The law is for the protection of all employees. The lives of carmen should not be endangered by requiring them to take unnecessary chances in a yard where switching is going on constantly to make repairs which might require considerable work between or underneath cars. In endeavoring to make repairs to a car on a yard track there is danger of tying up the terminals or seriously interfering with the operation of trains, all of which should be taken into consideration.

The Safety Appliance Act applies to equipment used on side tracks and yard tracks, as well as on main lines. A car having a penalty defect must under no circumstances be offered in interchange, nor must a car in this condition be received in interchange, as under the amendments above mentioned only the railroad on which the car becomes defective has a right to move a car for repairs on its own line.

The hauling of cars by means of chains in revenue trains or in connection with cars commercially used, except cars containing live stock or perishable freight is prohibited, unless such cars, when hauled, are not in revenue trains or in association with cars commercially used. It would be permissible to send a locomotive to haul in chained up cars to the nearest available point where the cars can be repaired. It would be a violation of the law to haul such cars even in a non-revenue train out of or through a point where the requisite repairs can be made; further the hauling of the car must be for the purpose of repairs and not for the purpose of disposing of the contents.

It might be well to sum up the Safety Appliance defects involving various parts of the car.

	Combinations of defects		Combinations of defects
Air brakes	34	Ladders	9
Hand brakes	101	Height of couplers	3
Hand holds	7	Sill steps	8
Uncoupling attachments	28	Safety railing	3
Coupler and parts	20	Hand railing	4
Running boards	16		

It may be noted by the above list of safety appliances that each becomes defective in numerous ways, many cases constituting reportable defects only, but all of sufficient importance to require close attention to avoid injury to employees and the traveling public.

Car Wheels and Their Defects*

A History of the Chilled Iron Wheel With a Discussion of Methods for Securing Maximum Service

BY W. F. TIDSWELL
Michigan Central, Detroit, Mich.

The first wheels designed to run on rails were made of wood, with the flange built up about an inch. These were introduced in 1649 and were used in all classes of service. They continued in general use until about 1753, at which time the cast iron wheel came into use. It took about fifteen years to convince people that the iron wheel had come to stay and in 1767 the cast iron wheel came into general use. The wheel hub was split and clamped on the axle with bolts through the hub and was also keyed to the axle.

In the years from 1767 to 1843 many different forms of wheels were brought out, the principal one of which was the double plate wheel. The general tread outline was the same as that in use at the present time. The tread was narrower, being 3¾ in. wide, the flange about 1¼ in. high and the standard wheel was 24 in. in diameter. The inside and outside plates extended from tread to tread, in a convex form.

Vertical Flange

Slid Flat Spots Causing Comby Tread

with a hollow space between the plates. The hub between the plates was separated about ½ in. The wheel was either shrunk on the axle or pressed on.

In 1849 a patent was granted to I. Van Kurran for a new design of wheel, and it became popular for a while. This was quite a departure from the wheel of 1843. It was a double plate wheel, but the plates met about half-way between the tread and hub, with a cored space between the tread and the center of the plate, and another cored space between the hub and the center, making two separate cores between the hub and tread. The tread was about 4 in. wide, 28 in. in diameter, and had a chilled tread. Chilled iron tires were used on locomotive drivers until 1865.

On October 8, 1850, N. Washburn was granted a patent for a double plate wheel, the two plates merging into one, and reinforced on the back by brackets or ribs. This style of wheel has been in general use since that time.

Previous to 1843, wheels were made of soft iron, the method of chilling the tread not being in use. The discovery of this, like many other important improvements was said to be accidental. About 1804, or 1805, a foundry man in England accidentally spilled some molten iron on a cold iron plate, and on examination, found it to be very much harder than iron poured into a sand mould, and from this simple beginning, the chilled iron car wheel was evolved.

The Washburn wheel weighed about 500 lb. The tread widths had been a subject which each railroad settled to suit its own particular ideas, there being no interchange of cars on different roads. Each car was run to the exchange point and the freight transferred to other roads. Another thing which prevented exchange of cars was the track widths. Each railroad established its own track gauge without any consideration for the other.

After the Master Car Builders Association was organized in 1866, many of the differences between different railroads were ironed out, and some agreement arrived upon, looking toward a standard system not only of car wheels, but many other car parts.

At that time cast iron wheels were in use under both freight and passenger cars. The design of the wheel and the method of manufacture had been left to the wheel makers, and it was not until 1893 a standard wheel was adopted.

In the early 70's, steel wheels came into use under passenger equipment, and in 1872 Mr. Adams, of the Boston & Albany, stated in the M. C. B. Convention, that the B. & A. was equipped with steel wheels under their entire passenger equipment. In 1868, a resolution was offered in the M. C. B. Convention, to make the standard track gage 4 ft. 8½ in., and the wheel tread 5 in. wide.

The standard axle also adopted at this time had journals 3¾ in. by 5½ in. It was not long after this, that a car of greater capacity was designed, with an axle with journal 3½ in. by 6 in. This was known as an E. L. L. (extra long and large). It is a wide step from this size to the 6 in. by 11 in. journal of the present.

WHEEL FAILURES

Briefly, the wheel failures or defects which justify renewal are as follows: Sharp flange or worn flange, shelled out, burnt chill, either from sliding or from brake application, worn tread, worn through the chill, chipped flange, chipped rim, etc. The most common cause for removal is worn flanges, next worn tread, tread worn hollow, then brake burn, brake slid, shelled out, worn through tread and cracked flanges. If there are no inherent defects which would cause their early removal, and if they are not subjected to abuses, such as wheels sliding, truck out of true, air brake not properly repaired, etc., etc., will last out their alloted time and mileage barring accidents.

WORN OR SHARP FLANGES

The first defect of car wheels to be considered is worn flanges. There are several reasons for worn flanges. One

*From a paper presented before the Car Foremen's Association of Chicago.

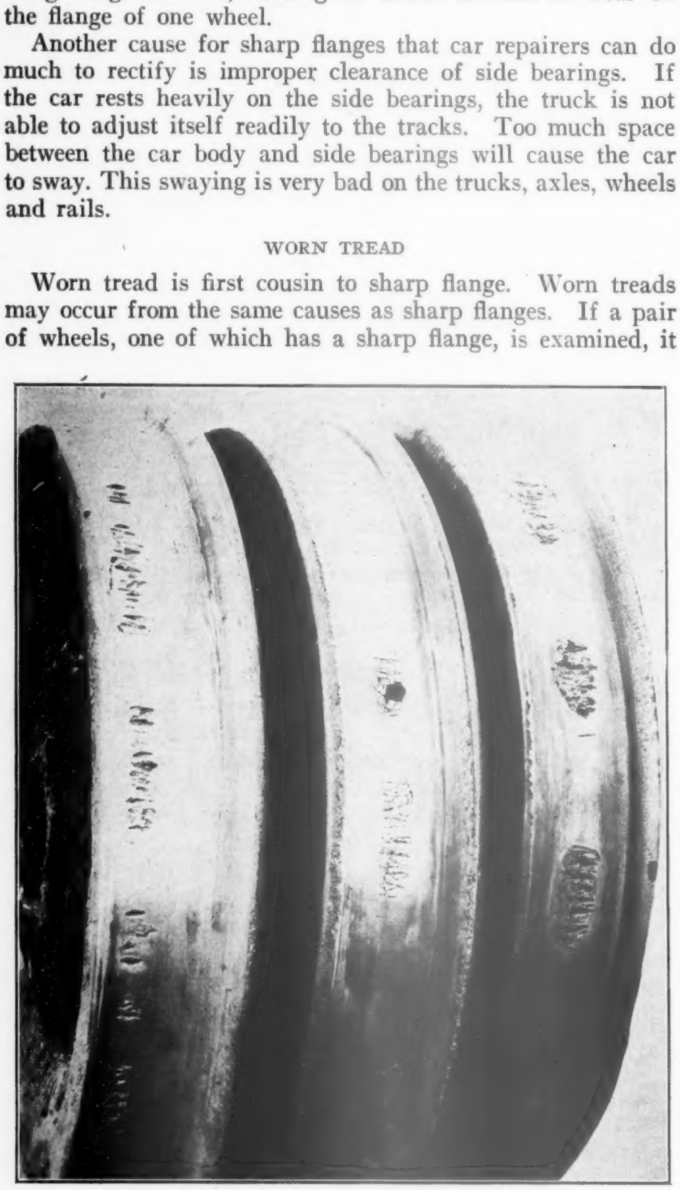
is the mismating of wheels when first mounted. When cast wheels are first made at the foundry, one of the first things done after the wheel is cleaned is to measure the circumference and mark the wheel accordingly. This is called "tapping" and the sizes marked on the plate of the wheel are called tape sizes. Wheels whose tape sizes do not correspond should not be mounted on the same axle.

Another reason for flange wear is that the truck may be out of square. When this is a fact, the wheels do not track properly. One wheel is ahead of its mate, consequently the flange hugs the rail, making an undue amount of wear on the flange of one wheel.

Another cause for sharp flanges that car repairers can do much to rectify is improper clearance of side bearings. If the car rests heavily on the side bearings, the truck is not able to adjust itself readily to the tracks. Too much space between the car body and side bearings will cause the car to sway. This swaying is very bad on the trucks, axles, wheels and rails.

WORN TREAD

Worn tread is first cousin to sharp flange. Worn treads may occur from the same causes as sharp flanges. If a pair of wheels, one of which has a sharp flange, is examined, it



Chilled Iron Wheels with Treads Destroyed by Brake Burns

is very liable that the companion wheel will be found with a worn tread, because the wheel having been run in one position grinds out the tread either on account of one wheel being larger than the other or the truck out of square.

There is one other cause which will produce these defects, and that is the wheels not being mounted equidistant from the ends of the axle. This not only causes the wheels to crowd against the rail, but it also brings an extra amount of wear on the journal collars.

BRAKE BURN OR BURNT CHILL

A wheel that is brake burnt is easily distinguished by cracks across the tread of the wheel. Sometimes these cracks are only hairlines, and in other cases there is a separation of the metal, a sixteenth of an inch or more in width, and covering the entire periphery of the wheel. This is caused by the brake application continuing for a long period, heating the tread of the wheel, and causing the iron to separate on account of the expansion of the metal.

Brake burns occur in some classes of equipment more frequently than in others, for instance, fast refrigerator line cars. These cars are designed for 60,000 lb. capacity, and are equipped with $4\frac{1}{4}$ in. by 8 in. axles and 625 lb. wheels. This class of car is not in the same kind of service as a 30 ton merchandise car, but on fast freight service. The speed at which these trains move is much faster than the ordinary freight train, consequently when it is necessary to stop the train there is a longer application of the brake. This naturally generates heat on the tread of the wheel, and as a result brake burns and broken plates occur more frequently in this service.

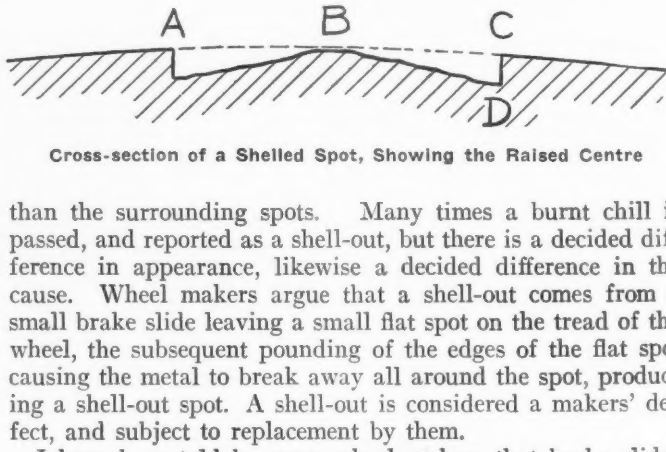
The design of the wheel does not provide sufficient metal to take up the heat. This causes the tread to expand, and as the tread expands the hairlines or separation of the metal occurs on the tread, or a crack in the plate of the wheel, resulting in either brake burns, cracked plates, cracked flanges or brake slides.

CHIPPED RIM

This occurs from the wheel tread being worn hollow, the high part of the rim striking on the switch frogs or switch points, breaking off the rim of the wheels. The heating of the treads is also responsible for cracks occurring in flanges, particularly so if the brake shoe crowds against the flange of the wheel. The flange not being large enough to carry away the heat, the expansion causes the flange to crack at the throat or fillet of the flange.

SHELLED OUT

A shelled-out wheel is one where the metal of the tread has shelled away from the center, leaving the center higher



Cross-section of a Shelled Spot, Showing the Raised Centre

than the surrounding spots. Many times a burnt chill is passed, and reported as a shell-out, but there is a decided difference in appearance, likewise a decided difference in the cause. Wheel makers argue that a shell-out comes from a small brake slide leaving a small flat spot on the tread of the wheel, the subsequent pounding of the edges of the flat spot causing the metal to break away all around the spot, producing a shell-out spot. A shell-out is considered a makers' defect, and subject to replacement by them.

I have been told by some wheel makers that brake slides have been found on engine truck wheels. I have never seen this, but I have seen a typical shell-out on wheels in this service.

Greater care should be taken in reporting the defects for which wheels are removed. If the inspector calls a brake burn a shell-out, and the next man who sees the defect reports it something else, there is bound to be confusion. It is this report that guides the man in the office in making up his records and charges.

CRACKED PLATES

Another frequent cause for wheel removals is cracked plates. Cracked plates are caused by the expansion of the

tread through heat generated by the brake shoe. The heating of the tread produces a strain on the wheel, at the juncture of the front and back plates.

BRAKE SLIDE

A brake slid wheel can do more damage to equipment and rails than any other wheel defect. The continual pounding of the flat spots on the rails will loosen every bolt in the truck, and broken rails are very often traced back to brake slid wheels. Spots where the wheel has worn through the chill have a close resemblance to brake slides, but are easily distinguished. The brake slide will have a flat spot with more or less sharp edges, whereas, a spot worn through the chill will have the edges worn over or rounded, leaving no well defined flat spot. A wheel worn through the chill is clearly a maker's defect, and one that cannot be told by inspection of the wheel when new. The wheel when made may have a much thinner chill on one side of the wheel than on the other, and there is no way of telling this except by breaking the wheel.

Shelled Out Spots on Wheel Tread

A very common cause for brake slides, and the causes are numerous, is defective brake rigging, due largely to lack of inspection to the air brakes. Another is the angle at which the brake shoe is hung from the truck. If the angle of the brake hanger in relation to the wheel is too great, the shoe on one pair of wheels in the truck will lock against the tread of the wheel producing tremendous leverage, while the other pair in the same truck will have but little leverage depending on the direction the wheel is revolving. This can be remedied in nearly all cases by bringing the point of suspension of the hanger closer to the wheel.

The number of accidents, the safety of the traveling public, and the successful transportation of freight depends largely on the careful inspection of each wheel under every car, so that defective wheels may be discovered and removed before there is a possibility of accident. The inspector should take no chances on a defective wheel, nor at the same time cause the removal of a wheel which is in the safe limits of good practice.

DISCUSSION

F. K. Vial (Association of Manufacturers of Chilled Car Wheels, emphasized the importance of the correct mating of car wheels when mounted on axles, and illustrated his remarks by figures showing that one wheel would slide a considerable distance even though tape figures are within 1/8 in. of each other. He also spoke of the difficulty of deciding the cause of shell-outs.

In answer to a question Mr. Tidswell stated that in many cases the breaking of flanges in the throat or fillet of the flange is caused by the brake shoe crowding against the flange of the wheel, which, when the brake is applied heats the flange of the wheel, which is not big enough to carry off the heat. He recommended that the brake beam and brake shoes be hung as nearly central with the axle as possible, which, if the beams are properly made, will bring the brake shoe square against the tread of the wheel.

It was brought out that a large part of the damage done to wheels was caused through neglect or improper inspection of the air brake equipment. Particularly Lawrence Wilcox (Westinghouse Air Brake Company) stated that four points which cover some of the more important features of air brake maintenance in which car foremen are directly interested and which are important factors in wheel damage are improper levers, proper maintenance of triple valves, a sufficient piston travel to eliminate excessive brake cylinder pressure for a given brake pipe reduction, and failure to make certain that the small exhaust port in the retaining valve is open when cars are on repair tracks, the percentage of these cases running as high as 35 per cent.

E. H. Mattingly (B. & O.) stated that the relationship of the triple valve with the brake burned wheel or the heated wheel is a very serious one and that it is the duty of the owners of cars to see that the triple valve is put in the best condition possible. Mr. Mattingly also laid stress on the importance of having minimum and maximum standards of adjustment of side bearing clearance.

Representatives of private car lines stated that the 625-lb. wheel was too light for refrigerator service, which includes high speed work with heavy breaking wear, but as the M. C. B. standards specified this weight for the type of car used, the private owners had no protection on the exchange of wheels should they adopt a heavier standard. It was generally agreed that a heavier wheel, weighing about 740 lb., would give increased efficiency in high speed freight cars of this type.

E. S. Way (General American Tank Car Company) stated that many wheels are removed for brake burns and chipped rims which are not at all dangerous and have a great deal of mileage left in them. He advocated closer personal instruction of shop and yard inspectors as to what constitutes a dangerous wheel.

A committee was appointed to look into the cause of wheel defects and report their finding, together with a recommendation for heavier wheels on refrigerator cars, to the American Railroad Association.

The Aeroplane Engine in Industry.—That the airplane engine is not above ordinary humdrum work is shown by the fact that one has recently been installed in a London factory as a stand-by power unit. It burns gas instead of petrol and the cooling water is circulated through a common cast-iron radiator. It is an eight-cylinder engine, surplus from the war, and at the aerial rate of living would develop 200 hp., but has been rated at 75 hp. on earth to give it a reasonable length of life.—*Compressed Air Magazine.*

INSPECTING CARS IN INTERCHANGE

Methods to be Followed to Comply Fully with the M. C. B. Rules and to Locate All Important Defects

The following suggestions are for the purpose of educating and impressing upon the minds of all inspectors and follow-up men the practices to be observed in their everyday duties and to bring about uniformity of inspection.

The first duty of the inspectors is to be in the yard when the train pulls in, to see if they can detect, as the train passes, by sound or sight, any defect, especially of the truck and wheels, which would not be detected when car is not in motion, and checking such equipment with a mark so that it will immediately come to their attention when they reach the car in their regular duties. Contrary to this, many inspectors remain in their buildings until the road engine cuts off, which indicates that the inspector does not have the proper spirit nor take the lively interest in the work that he should.

Before going over the train, as he reaches the end of the string of cars the inspector should be absolutely certain that the blue flag or blue light is on each end of the string.

The method of inspecting a car should be as follows: On reaching the end of the car, the two ground inspectors must view all parts on the end of the car, including the couplers, carrier irons and outward parts up to the roof. They should then look beneath the car at the outer pair of wheels to inspect the brake beam, connections, bolster, draft rigging, sills, etc. They should next advance to the inner wheel, making a similar inspection of all parts under the car and before advancing to the center of the car for door inspection, etc., should cover the complete side of the car including side ladders, raising all box covers to see that the packing, brasses and wedges are in good condition and, above all, be extremely careful in inspecting the truck sides, arch bars, etc. The inspectors should then pass on to the center of the car, stooping to examine all truss rods, cross tie beams, vital parts of the air brakes and brake connections and repeat the same performance on the other end of the car.

OVERHEAD INSPECTION

The overhead inspection is usually covered as a whole, by a special man going over the top of the string in advance of the ground men in some yards, but the most thorough inspection, with the best results, is secured by having the overhead inspection made in the presence of the ground men, so that the hand brake can be set up and tried by the overhead inspector, and the two ground men can observe that everything is in good condition. It is strongly recommended that this practice be carried out to give a more perfect overhead inspection, not neglecting the lateral and longitudinal running boards and all parts of the brake staff, including the brake step-board, ratchet and other parts, and the usual careful attention of the roof handholds.

On open-top loaded cars special attention must be given to the condition of the load; where it is loaded with bulk commodities, such as coal, etc., it must be observed and depressions recorded that would indicate loss. On cars loaded with boxes, cases or other parts, the overhead inspection should include the condition of bracing and blocking and general method of securing the load and damage and breaking that may be observed on the parts.

On open-top, empty cars, special attention must be given to the inside cross braces, the condition of the floor, and where any refuse is left in the car it should be had ordered for cleaning.

On empty box or other closed cars, before classifying for loading, an interior inspection must be made for leaks through the roof, floor and siding, stains or odors of oil, fertilizer and other objectionable matter; refuse of material that will leave such stains or odors injurious to grain or flour. Cars with such defects and otherwise physically fit should be classed for rough freight or merchandise loading.

INSPECTING THE BODY OF THE CAR

The center sills or channels, extending from end to end in the center of the car, to which the draft gear is attached, should be in perfect condition to withstand the pulling and buffing stresses. The draft timbers are attached to the center sills by bolts to support the coupler and attachments, and it is necessary that these timbers be tightly drawn up to the center sills to prevent movement back and forward thereby elongating the draft bolt holes in the center sills and consequently weakening the sills.

In wooden cars the end sill extends across the end of the longitudinal sills, retaining the longitudinal sills in position. The end sill also holds the body truss rods and distributes buffing shocks of all the sills.

The body bolster, commonly called body transom, connects and retains in position the longitudinal sills over which the weight of the load is distributed. Fractures in this member usually develop in the center, near or at the center plate, rendering the bolster liable to collapse, causing contact of the side sills with the truck sides or frames and severe binding at the side bearings, and also causing the possibility of derailment.

The cross tie timbers, and body truss rods support the car at the center and should be kept in good condition, insofar as retaining the truss rod castings in place is concerned. The rods should at all times be tight to prevent sagging of the car in the center when loaded.

The coupler should at all times be maintained in first class condition and should, therefore, receive careful inspection and attention with respect to the proper contour of the coupler head and knuckle, also to see that the lock and parts, knuckle pin, uncoupling lever and parts are in good condition and always operative. A test should be made by inspectors of the uncoupling device to determine its condition, also of the knuckle pins, defect in which are usually easily discernible.

The coupler yoke rivets, by which the coupler is secured to the yoke, must receive careful attention, as these are very essential parts. When found defective they should be condemned for immediate repairs, depending upon the number remaining effective and the coupler yoke having a gib. Failure of these parts causes considerable damage to sills and draft gear.

The carrier iron is attached to the front end of the draft timbers supporting the coupler and allowing lateral motion, also preventing the spreading of draft timbers. The bolts holding it in place are very essential in order to maintain proper coupler height.

DEFECTS OF TRUCKS

Trucksides and arch bars are the foundation of the car and are designed of sufficient strength to support the weight of the car, plus the weight of lading the car is supposed to carry. A fracture or crack reduces the margin of safety to such an extent that the part is liable to break off with added strain or motion. The fracture usually occurs at the lower web of the arch, as the greatest weight is distributed to that point by its construction. This should not confine the ex-

amination to this point, however, as the arch bar or truck side is frequently broken at the top or other points.

The bolster is the key to the truck, distributing the motion in curving, binding the two sides, and absorbing the greatest shocks of irregular track. A broken bolster may cause the truck to collapse or the body to fall down on the truck sides. The fracture usually occurs at the center or near the spring seat.

The spring plank is a secondary binder of the two sides and a fracture may cause the collapse of the truck. Fracture occurs mostly at the spring seat, in modern type of truck.

Broken journal boxes should not be allowed to run as they cause loss of lubrication, misplacement of the journal bearing and consequent cut journals.

The truck column and journal box bolts and nuts are used to tie the various parts into one piece. The loss or looseness of the nuts of such parts may cause the bars to spread, by taking away the strength of the arch, tie scraps to fall down on the track, or the journal box to slide out of the arch, causing derailment. Special attention must be paid to these parts on all repair tracks and in all yards.

DEFECTS OF WHEELS AND AXLES

Flat sliding (Rule 68): A wheel slid 2½ in. or over in length, or one with adjoining spots 2 in. in length, produces a continuous pound with each revolution of the wheel. This pound is destructive to the rail as well as to the wheel itself and may cause either or both to break. This defect can best be detected when the car is in motion and should be looked for on incoming trains.

Broken flange, chipped flange (Rule 78): A wheel having a broken or chipped flange may mount the rail in motion and cause derailment. Measurements may be made with the wheel gage; the lengths from the journal collar notch to the second notch measures 1½ in.

Broken rim (Rule 70): A broken rim if inside the 3¾ in. limit reduces the surface of tread so much that the wheel may leave the rail. Measurements are made by placing the gage horizontally on the tread. When the break occurs inside the semi-circular slot, it is condemnable.

Shelled out wheels and brake burn (Rule 71): Shelled out wheels are distinguishable by comby spots on the tread. When such a single spot is 2½ in. or over in diameter, it will pound similar to a slid flat wheel with the same danger to the wheel and the rail. Brake burn is the first symptom of shelled out wheels. Hard and prolonged applications of the brakes having destroyed the chill, or hardened outer surface renders it subject to breakage.

Seamed wheel (Rule 72): A seam ½ in. long in the tread ½ in. from throat of the flange or 3 in. long, within 3¾ in. from the flange may cause either the flange or rim to break off and derail the car, by mounting or leaving the rail.

Worn through chill (Rule 73): Many inspectors call this "worn flat wheel." It shows up by a spot 2½ in. long or over, worn smoothly flat. This is caused by the hardened surface in the tread, known as the "chill" wearing through into the inner, softer metal of the wheel. This condition destroys the bearing surface of the wheel and renders it subject to breakage.

Worn flange (Rule 74): Wheels under cars of less than 80,000 lb. capacity 15/16 in. or less in thickness and wheels under cars of more than 80,000 lb. capacity 1 in. or less in thickness, ⅜ in. from the tread are condemnable. A vertical flange may not take this gage, but when the wheel is less than 80,000 lb. capacity, with a vertical flange extending 1 in. or more from the tread or on wheels of 80,000 lb. capacity or over extend ⅞ in. or more from the tread, the flange and tread contour are worn out to such an extent that the wheel may mount switch points or cause the flange to break off. Great care must be shown in the use of the gage in order to condemn wheels only when actually defective.

Tread worn hollow (Rule 76): A hollow tread may be brought about by an irregularity in the truck, or the improper mounting of wheels, or in other cases by long wear. The tread becomes concave, making the rim liable to break off.

Burst plate, hub or brackets (Rule 77-78): Wheels cracked outward by axle pressure and wheel plates and brackets cracked by expansion from severe brake heating are very dangerous, more especially so because of the difficulty in detection. Both the outside and inside plates must be most carefully examined.

Loose wheel (Rule 81): A wheel loose on the axle is usually caused by imperfect mounting. It is a most difficult defect at all times to define with certainty, but good and general indications are grease on the axle, hub or seat inside the wheel. Care must be exercised not to confuse grease with the paint used for mounting the wheel on the axle. This defect is most easily seen from the opposite side of the car.

Bent axle. An axle bent to any extent will shorten. The distance between the wheels, at one point of its revolution, and the tread of the wheel will not bear fully on the rail at this point, which may cause a derailment. This is a very dangerous defect and can best be detected while the car is in motion, when it is indicated by a jumping movement. If a car shows evidence of having been derailed the inspector should gage the wheels to test for bent axles.

Cut journals, hot journals and associated defects may lead to crystalization of the journal and breaking off, twisting off by burning and severe heating. This is one of the defects that causes greater delay to freight than any other item. Defective journals can most readily be detected immediately after the train comes to a stop by indications of heat and burning of packing. When this is not possible, or the journal has been cooled off and repacked, the face of the journal will show a blackened surface or the wheel plate will be smeared with oil. Such journals must be tested with the inspectors' hook, and if they show ridges, they should be cut out for truing up at the shops.

Brake beams, levers, hangers, connections, lever pins and cotters, brake shoes and keys, in order to perform the function for which they are put on the car, must be in place and properly secured. No part of the truck or brake rigging should be below 2½ in. from the rail. Worn cut pins, brake hangers, brake beam eyes, etc., should be renewed or shopped for repairs. Cotters should be spread to prevent dropping out. Owing to the fact that these parts are all connected with each other, the loss of one item may mean a further loss and many times may cause derailment; or the inability of the brakeman to stop the car may result in its entire destruction and loss of life.

SAFETY APPLIANCE INSPECTION

It is very important that close and careful inspection be made of all safety appliances to see that they are perfect in all details, as such parts are in constant use and must of necessity be free from defects both in parts themselves and parts that are used in application, having in mind at all times the requirements of the government insofar as proper size of material and location is concerned, regarding handholds, sill steps, ladder treads, etc. The inspection should be thorough in order to detect defects, particularly in the offset of handholds, ladder treads and sillsteps, to see that the brake pawl and parts are secure and engage the ratchet wheel.

Interchange and industrial inspection is a distinct and absolute necessity and so realized by all branches of the service, and the object of these suggestions is to concentrate our very best effort on keeping the inspection forces alive to their duties and thereby improve the service and overcome any negligence tending to lower the standard and warrant criticism.

STANDARD FREIGHT CARS PRACTICALLY COMPLETED

The orders for standard freight cars, placed by the United States Railroad Administration, have been completed, except for a very small number and have been allocated to the various railroads under Federal control.

The orders for the building of these cars were distributed, by the Railroad Administration, to the car building companies throughout the United States and were constructed with a speed and in a manner to reflect credit on the builders.

After the signing of the armistice many of the railroads were reluctant to accept allottments of these standard cars because of a falling off in railroad business and a considerable number of cars were held in storage for some months. However, business conditions improved considerably in the latter half of the year 1919, and practically all of these cars have now been distributed.

Of the total of 100,000 freight cars ordered by the Railroad Administration on May 1, 1918, but 16,636 remained to be built on November 8, and these were being constructed and put into service at the rate of over two hundred a day. By November 1 all the cars which had been completed and placed in storage on account of some of the railroad corporations refusing to accept the cars allocated to them had been stenciled and put into service, so that, from August 1 to November 8, 53,305 new freight cars had been added to the rolling stock of the railroads. Only 168 of those completed remained to be lettered, numbered and placed in service on November 6.

Tables of equipment purchased by Railroad Administration for the railway companies, showing contract cost, character, and allocation to the various railroads and attitude of railroads touching its acceptance.

FREIGHT CARS.

Name of railroad.	50-ton single-sheathed box.	40-ton double-sheathed box.	50-ton composite gondola.	55-ton hopper.	70-ton low-side gondola.	Total.	Total cost.	Corporation action.	
								Accept.	Object.
Ann Arbor R. R.	300					300	$915,000		Yes.
Atchison, Topeka & Santa Fe Ry		1,700	1,000			2,700	7,659,300		
Atlanta, Birmingham & Atlantic Ry	200		150			350	1,014,550	Yes	
Atlantic Coast Line		950	300			1,250	3,582,150	Yes	
Baltimore & Ohio R. R.	2,000		1,000	2,000	500	5,500	16,018,000		
Bangor & Aroostook R. R.									
Bessemer & Lake Erie R. R.				500		500	1,408,500	Yes	
Boston & Maine R. R.		500	1,500			2,000	5,505,000	Yes	
Buffalo, Rochester & Pittsburgh Ry				800		800	2,253,600		Yes.
Carolina, Clinchfield & Ohio Ry	300			750		1,050	3,027,750	Yes	
Central R. R. of New Jersey	500			500	500	1,500	4,520,500		Yes.
Charleston & Western Carolina Ry		300				300	875,700	Yes	
Chesapeake & Ohio Ry	1,000			2,000		3,000	8,684,000		Yes.
Chicago & Alton R. R.			500			500	1,348,500		Yes.
Chicago & Eastern Illinois R. R.		500	500			1,000	2,808,000		Yes.
Chicago & North Western Ry	1,000	1,250	1,000			3,250	9,395,750	Yes	
Chicago, Burlington & Quincy R. R.		500	1,000			1,500	4,156,500	Yes	
Chicago, Indianapolis & Louisville Ry		300				300	875,700		Yes.
Chicago, Milwaukee & St. Paul Ry	2,000					2,000	6,100,000	Yes	
Chicago, Rock Island & Pacific Ry		1,000	1,000			2,000	5,616,000		Yes.
Chicago, St. Paul, Minneapolis & Omaha Ry		500	200			700	1,998,900		
Cincinnati, Indianapolis & Western R. R.									
Cleveland, Cincinnati, Chicago & St. Louis Ry		1,000		1,000		2,000	5,736,000	Yes	
Colorado & Southern Ry				300		300	845,100	Yes	
Delaware & Hudson R. R.	500			1,000		1,500	4,342,000		Yes.
Delaware, Lackawanna & Western R. R.			500	700	500	1,700	4,907,400		Yes.
Detroit, Toledo & Ironton R. R.			300			300	809,100		Yes.
Duluth, South Shore & Atlantic Ry									
Elgin, Joliet & Eastern Ry		500				500	1,459,500	Yes	
El Paso & Southwestern R. R.			250			250	674,250		
Erie R. R.	1,000		800	700		2,500	7,179,500		Yes.
Florida East Coast Ry	500					500	1,525,000		Yes.
Georgia R. R.	300		100			400	1,184,700	Yes	
Grand Rapids & Indiana R. R.	250		50			300	897,350		
Grand Trunk Western Ry		1,000				1,000	2,919,000		Yes.
Great Northern Ry		1,500				1,500	4,378,500	Yes	
Hocking Valley Ry			500			500	1,348,500		Yes.
Illinois Central R. R.			1,000	1,000		2,000	5,514,000	Yes	
Kanawha & Michigan Ry				500		500	1,408,500	Yes	
Kansas City Southern Ry				300		300	845,100		Yes.
Lehigh Valley R. R.			500	1,300	500	2,300	6,597,600		Yes.
Long Island R. R.			200	300		500	1,384,500	Yes	
Louisville & Nashville R. R.			1,000	1,000		2,000	5,514,000	Yes	
Maine Central R. R.	300					300	915,000	Yes	
Michigan Central R. R.	1,000		1,000			2,000	5,747,000	Yes	
Minneapolis & St. Louis R. R.		300				300	875,700		Yes.
Missouri Pacific R. R.		1,500	1,000			2,500	7,075,500	Yes	
Mobile & Ohio R. R.				100		100	281,700		Yes.
Nashville, Chattanooga & St. Louis Ry			200			200	539,400	Yes	
New York Central R. R.	1,000	1,000	1,000	1,000	500	4,500	13,070,000	Yes	
New York, Chicago & St. Louis R. R.		500				500	1,459,500		Yes.
New York, New Haven & Hartford R. R.				1,500		1,500	4,225,500	Yes	
Norfolk & Western Ry	800					800	2,440,000	Yes	
Norfolk Southern R. R.	200					200	610,000		Yes.
Northern Pacific Ry									
Northwestern Pacific R. R.		100				100	291,900		
Pennsylvania Co. (West) incl.	3,500		500	2,000	1,000	7,000	22,297,500	Yes	
Pennsylvania Co. (east)	3,000			1,000	500	4,500	14,287,000	Yes	
Pere Marquette Ry		500	500			1,000	2,808,000		Yes.
Philadelphia & Reading Ry	1,000			2,000	500	3,500	10,271,000		Yes.
Pittsburgh & Lake Erie R. R.	500				500	1,000	3,112,000	Yes	
Richmond, Fredericksburg & Potomac R. R.	500					500	1,525,000	Yes	
St. Louis-San Francisco Ry		1,500	1,000			2,500	7,075,500		Yes.
Seaboard Air Line Ry	500					500	1,525,000		Yes.
Southern Pacific Co.	1,000					1,000	3,050,000	Yes	
Southern Ry		2,000				2,000	5,838,000		Yes.
Spokane, Portland & Seattle Ry		300				300	875,700		Yes.
Texas & Pacific Ry									
Toledo & Ohio Central Ry		250		500		750	2,138,250	Yes	
Toledo, St. Louis & Western R. R.				350		350	985,950	Yes	
Union Pacific System									
Wabash Ry		1,500	1,000			2,500	7,075,500		Yes.
Western Maryland Ry	300					300	915,000		
Wheeling & Lake Erie Ry				1,000		1,000	2,817,000		
Assigned	23,450	20,950	19,550	21,100	5,000	93,050	271,360,000		
Unassigned	1,550	4,050	450	900		6,950	20,298,400		
Ordered	25,000	25,000	20,000	25,000	5,000	100,000	291,659,000		

SHOP PRACTICE

JIGS AND SPECIAL DEVICES IN LOCOMOTIVE REPAIR SHOPS

By J. C. BEVELLE

Tool Foreman, El Paso & Southwestern, El Paso, Tex.

In Figure 1 there are shown two flue sheet cutters, one for small boiler flue holes and the other for large superheater flue holes. The advantages in the small cutter is that the maintenance cost is very small on account of the cutter blade being made of flat bar stock and not requiring much machining. The blade is made of high speed steel similar to a counterbore and the cutter holder is made of a low car-

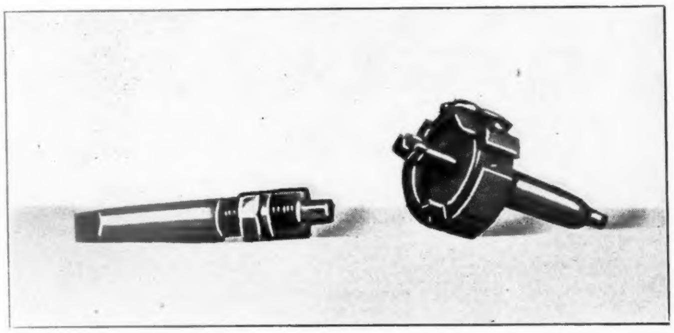


Fig. 1

bon steel, hardened and tempered. The cutting edge of the blade is ground with a lip which makes it free cutting and curls the clips. This tool drills the hole in 40 sec. and stands up well under all conditions.

The superheater flue sheet cutter is made so that it will cut all sizes required for superheater flues with one set of blades. With the milled places in the cutter body as shown in Fig. 1, it is only necessary to remove the blades and

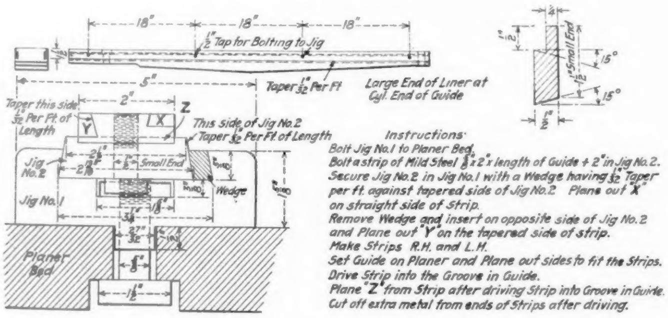


Fig. 2

place them in the desired set of slots, which have the diameters stencilled on them. This cutter is made to cut two sizes but has space for one more set of slots. The cutter so designed eliminates the many different kinds of blades and different sizes to be carried on hand as the one set of blades will cut any size wanted by transferring to the proper slots. The blades are made of high speed steel and the cutter body is made of machine steel.

The construction of jigs used in reclaiming locomotive guide bars, is illustrated in Fig. 2, which is self explanatory. These bars are reclaimed by planing a dove-tailed slot on each edge of the bar and applying an iron strip planed to suit the slot, then planing it off to size, bringing the guide bar back to standard size. This has proved to be a great success and all guide bars are being so reclaimed. After the bar has been planed out, if the strips are worn out, new strips can be applied and the life of the bar is prolonged indefinitely.

Fig. 3 illustrates the method of milling throttle lever quadrants on a universal milling machine. The quadrants are placed on a jig as shown, and held in place by the dividing head, the length of the jig giving the proper radius for the quadrant. The cutter is made with the proper pitch and the same radius as the quadrant and has 20 teeth. The

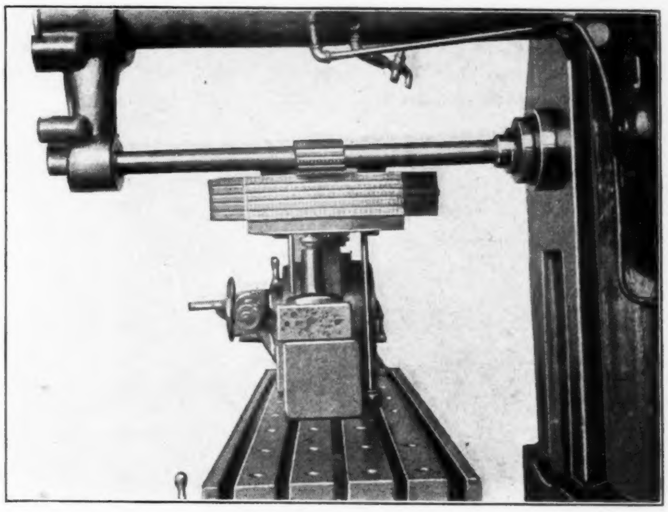


Fig. 3

quadrants are placed on the jig, six at one time, clamped down and the cutter put to work. The cutter finishes the quadrant teeth on the face as well as at the bottom of the tooth, making it unnecessary to turn the outside radius as it was when a single cutter was used. There being six quadrants on the jig at one time and twenty teeth in the milling cutter, 120 teeth are finished per traverse of the table of the machine. Six quadrants can be milled in one and one-half hours, or 15 min. per quadrant. The cutter is made of carbon steel and the dimensions are 3½ in. by 3½ in. with 1¼-in. arbor hole.

Fig. 4 shows a method of milling throttle quadrant latches with a cutter similar to that shown in Fig. 3. The latches are held in a vise, two rows, six latches in a row, making 12 latches completed in one setting of the machine and with two traverses of the table. The time for this operation milling the teeth in 12 latches is 40 min. or about 3 min. per latch. The cutter is 3 in. in diameter, 1½ in. wide, with a 1¼-in. arbor hole and is of carbon steel. The face of the cutter is formed, on the segment of a circle having

the same center as that of the cutter for quadrants, giving the latch the proper radius on the face, allowing the teeth to fit each other and making a much better job than when the latch was milled straight.

A set of forging machine dies used for manufacturing superheater element tubes is shown in Fig. 5. This is done on a 2-in. Ajax forging machine. The tubes are of steel tubing and the end is upset with these dies in two

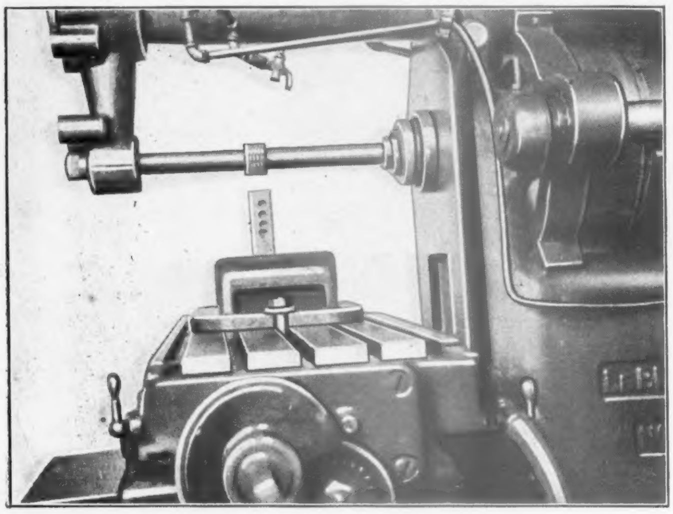


Fig. 4

operations and two heats. The first operation does about half the upsetting and the second operation completes the upsetting and forms the end to its proper shape. The tubes are then taken to a turret lathe and the ball joint is finished. They are then taken to the pipe shop where they are bent, threaded elbows applied, and bands applied. This shop manufactures all superheater unit tubes for renewals, and they have proved to be just as good or better than those

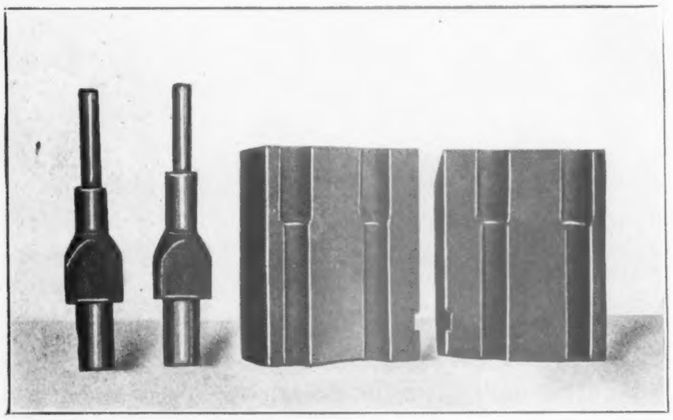


Fig. 5

bought and very much cheaper. These dies are made of machine steel and the heading tools are made of tool steel. The dies have been in service for four years and have made a large number of tubes.

A special prepared lubrication for air drills has recently been adopted on the E. P. & S. W. This consists of No. 2 compression cup grease and valve oil. The proportions are two-thirds cup grease and one-third valve oil thoroughly mixed together which gives a splendid mixture for air motors. The grease and oil are mixed with a butterfly paddle driven with an air motor. Air hammers are lubricated in a bath of coal oil and lard oil. The proportions are one-third lard oil and two-thirds coal oil. This is done at night when all air hammers are turned in to the tool room. They are allowed to remain in the oil all night, and if there is any dirt collected in the hammer or strainer it is dissolved by the oil which eliminates many repairs of the hammer.

Fig. 6 shows a method of machining the key-way in wrist

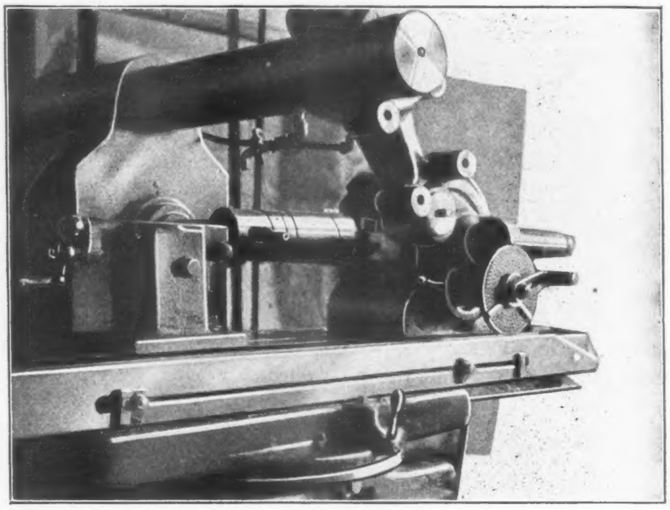


Fig. 6

pins on a universal milling machine, which is the same method used on piston rod key-ways. The key is milled with a radius cutter. The knuckle pin or wrist pin is first drilled with one hold and then milled, finishing the job. It is not necessary to touch the key-way by hand. Knuckle pins and wrist pins are milled in 10 min. each. The adop-

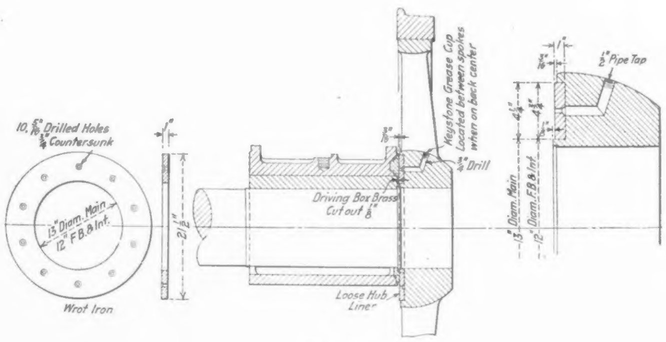


Fig. 7

tion of the key is so far better than the old method that we never apply a threaded pin.

It is the practice on this road to apply hardened steel bushings and pins on all link motion work. This has been our practice for many years and is very successful. The bushings are not ground on the inside after they have been hardened but are lapped out, making the hole as good as possible for the fitting of the pin. The pins are ground on a Brown & Sharpe grinding machine to fit the bushing. We don't know what it is to find a galled pin and our running repairs on this work are very light. It is rightly believed that after the bushings have been applied to the various rods, etc., that they should be placed on an internal grinding machine and the hole ground out to a standard size.

The pin can then be ground to have a more perfect bearing, giving the job a much higher effectiveness. Internal grinding in locomotive repair shops is somewhat new outside of the tool work but has a large field in the shop, and the sooner we admit this to ourselves the sooner we will overcome some of our troubles.

Fig. 7 shows the application of a floating hub liner. This

liner is applied to a number of our Pacific and Mikado type engines. With this floating liner it is not necessary to shop the engine for lateral before it has made the required mileage which is 80,000 miles. On a recent date one of our Pacific type engines which has made 80,000 miles was put in the back shop for a classified repair, and on examining the hub liners and checking the lateral it was found that the lateral was 1/8 in. less than the limit, which is 3/4 in. A Mikado engine which made 65,000 miles was given the same inspection and found to be 3/16 in. less than the limit for lateral. The liners were scarcely worn at all and it was not necessary to renew them. This is becoming a standard liner on our system.

We must not forget that while manufacturing new devices and tools that in each case we should keep in mind the need of safety. The prevention of injuries should be considered even more than the efficiency of the tool or device. Do you ever inspect the tools that are in daily use in your shop to see that they are in a safe condition? The tool foreman should make this his business as he is more capable of determining the safety of tools. Our shop safety committee demands a report from the tool foreman on tools in all departments and this has brought about wonderful results in a decrease of injuries. The blacksmith shop, boiler shop, and even the different tool rooms are good places to find defective tools. Handle tools, chisel bars and chisels are very dangerous and are as a rule given very little attention. Safeguards on machines should be watched, grinding wheels should be daily inspected, the tool rests should be up in place at all times, the mounting of wheels should be watched very closely. There are numerous things in the shops and engine houses that are unsafe at their best and we must see that they are kept at their best and in a safe condition.

Efficiency in Railroad Shops*

The Importance with Increased Labor Costs of Improved Shop Facilities and New Machine Tools

BY FRANK McMANAMY

Assistant Director, Division of Operation

SHOP efficiency is a subject that is usually very closely associated in the minds of most of us with intensive production and stop-watch studies of the different operations in connection with shop output, and from that viewpoint it is a subject which can never be exhausted. There is no doubt but that a great deal has been and can be accomplished in that way in the matter of increasing production, although it is usually done at the expense of a more or less serious dispute with the workmen. I have sometimes found that while making time studies of shop operations with split-second stop-watches, we were overlooking conditions and methods where the time that might be saved could be measured with the hour-glass, and that we are, in many of our shops, using machines and methods that are as far behind the most modern and up-to-date practices as the hour-glass is behind the split-second stop-watch.

The transportation machine has, perhaps, been left by the war in more nearly a normal condition than any other industry for the reason that while it was worked to capacity during the war—in fact, most of the time was overworked—yet, owing to the limited facilities, it was not possible to greatly enlarge the plant and there are no greatly increased forces because both were impossible to obtain during the war. The increased transportation furnished represented almost wholly increased effort on the part of those producing transportation and increased output of existing railroad facilities.

The change which appears to be most important and far-reaching so far as the railroad shops are concerned, is the change in working conditions and the increase in the rates of pay of railroad shop labor both skilled and unskilled, and to my mind, this is a change which is permanent; therefore, it must be reckoned with in all calculations relating to the purchase or maintenance of shop equipment. These changes have made it essential to see that our men are provided with modern tools and improved facilities, because in no other way can operating costs be reduced and kept at a reasonable figure.

*Abstract of a paper read before the New England Railway Club.

The use of out-of-date tools and machinery in railroad shops—although never satisfactory—may have been in the interests of economy at the rates paid for labor before the war, but under the rates now paid the use of inefficient machinery is not only unsatisfactory but decidedly expensive.

It is a well-known fact that many railroad shops, together with their equipment, were at the time the railroads were taken over by the government, and are today almost hopelessly out of date, and that the methods which this lack of facilities makes necessary are such that no manufacturing industry operated on a competitive basis could practice and exist. In fact, it has been stated that $10,000,000 spent for shops and shop machinery prior to 1917 would have made it unnecessary for the government to have assumed control of the railroads. Whether or not this statement is true, it is a fact that one of the principal reasons for taking over the railroads was the condition of locomotives and cars in certain sections of the country which, together with insufficient terminal facilities and the effort of many shippers to use the cars as storehouses, caused such a congestion that nothing short of centralized control with complete authority could have met the situation.

A survey of the situation immediately following federal control showed many railroads hopelessly behind in the matter of repairs to equipment, due to their limited shop capacity, although it was proved that the total shop capacity of the country, if properly distributed, was sufficient to maintain the equipment. The inadequacy of existing shops and the character and quantity of shop machinery was one of the things that received immediate consideration from the Railroad Administration, and while it was impossible in the time at hand and under war conditions to start and complete large, new projects, the matter of providing additional equipment and facilities at existing shops received earnest consideration and vigorous handling.

Investigations of shops and shop facilities during this period confirmed a belief that many of us had that the importance of having shop facilities on any railroad keep pace with other improvements is usually neglected and fre-

quently entirely overlooked. To promote efficient operation, grades are cut down, curvature reduced, terminal facilities are added, bridges and roadbed improved and strengthened to meet the requirements of new and heavier equipment, but the last thing that is given consideration—if, in fact, it receives any consideration at all until it is forced by the condition of power and terminal delays—is the question of providing shop and roundhouse facilities for the new and heavier equipment.

The general rule in the matter of making improvements is that if the saving to be brought about by the improved facility will pay the carrying charge on the investment, the improvement is a justifiable one, and under this rule, we have all seen locomotives and other equipment scrapped because of obsclescence—that is because the work performed by the more modern equipment was sufficient to pay the carrying charge on the investment, and therefore, the additional investment was justifiable. Locomotives from 15 to 20 years old are either modernized by rebuilding or scrapped to make room for modern power, yet a trip through the shops on practically any railroad will show that we are trying to maintain this modern power with shop tools and machinery, much of which is more than 50 years old and which should have been replaced by modern equipment years ago.

I am familiar with the statements which will probably be made that the reason for failure to provide proper equipment in the shops is because of the difficulty of financing, but this does not cover the case because a check of the service performed by locomotives and the time lost at terminals will show that in many cases it would have been profitable to have spent the money that was spent for the last order of locomotives in providing shop facilities to maintain locomotives already on the line, and that if this had been done, the additional locomotives would not have been needed.

EFFICIENCY

Efficiency, as applied to railroad shops, is, therefore, the ratio of the shop output to the time, labor, material and capital expended. In order that a railroad shop may be efficient, it is necessary to have: first, suitable shop buildings with proper equipment and lay-out; second, an effective shop organization; third, necessary schedules so that the various departments of the railroad in any way related to the shop organization may be able to coordinate their efforts.

The efficient railroad shop must have as its fundamentals proper equipment suitably disposed and properly housed. It is difficult to understand, in view of the saving to be effected thereby, why we have so long failed to erect suitable buildings for shop purposes, and this not only applies to the car department where suitable buildings do not exist, but also to the locomotive department where the loss of output in decreased efficiency due to placing machines in badly lighted, poorly arranged buildings where unusual effort is required to deliver material to and from machines which are not accessible even to an ordinary warehouse truck, is really a very serious question. So far as possible, the travel of material through the shop should be arranged to eliminate back-hauls. The material should move in as nearly a straight line as possible from the foundry or smith shop to the locomotive or car. I have seen shops where driving box brasses were machined at one end of the shop and pressed into the box at the other end of the shop several hundred feet distant; then returned for boring.

When any new shop machinery is requisitioned at the present time, the purchase is objected to on the grounds of its high cost, and this argument has been very effectively used. We must now, however, consider this in the light of the comparative cost for machinery and labor, and when we consider the rate paid to shop labor at the present time, we will realize that in the life of the average machine, its cost will be paid many times by the saving in the time of the workmen, to say nothing of the increase in efficiency and shop output and the additional service obtained from locomotives and cars, which are often sorely needed.

A very costly part of shop operation is the handling of material in the shop. For that reason, crane transportation, where it can be installed, is desirable, and in any event, wide aisles for the trucking of materials should be provided.

Shop machinery should be located with a view to the use to be made of it, with machines or appliances for each particular kind of work in one group. For example, all the work belonging to the valve motion should be handled in one place. Similarly, driving box work and brake rigging work should be located in one particular portion of the shop.

Someone has said, "Information is the essence of efficient operation." Nowhere is this more true than in the proper conduct of a railroad shop, and generally speaking, in few places is information as to probable requirements so sparingly furnished. Locomotives sent to the shop for repairs which are said to require the removal of a set of flues are found to require fireboxes, and locomotives sent to the shop for fireboxes are found to need only a set of flues. It is of great importance that proper record of the condition of locomotives and cars be kept and the shops furnished as much in advance as possible with information as to the repairs which will be required on equipment destined for the shop within the next two or three months in order that the shops can provide the necessary material when the locomotive or car is placed in the shop, thereby avoiding the too common practice of having them occupy valuable space while waiting on material.

ORGANIZATION

Organization is defined as, "A systematic union of individuals in a body whose officers, agents and members work together for a common end." This is especially applicable to railroad shops where the ends sought are efficient production and minimum costs. While to some it may seem unfair that brilliant, individual performances should be submerged in an average, at the same time, whether in baseball or business, team work is essentially the thing that counts.

Without an organization embodying as well as implying co-operation, little, if anything, will be gained, and this is entirely up to the supervision. Each investigation made of points where shop output is unsatisfactory confirms the belief which I have long had that effective and constant supervision is necessary in order to obtain a satisfactory output. Quality as well as quantity in production comes from the top downward. The average workman will give you, in the matter of output, exactly what you are willing to take. If the supervision is satisfied with a minimum performance and low-grade work, that is exactly what they will get.

If we are to have efficient operation in any shop, we must have supervision that is constantly on the job, and will show that the officials and foremen are as much interested in both the quantity and quality of output as they expect the workmen to be, and that they are willing to aid in promoting efficiency by seeing that the workmen have: first, a suitable place to work; second, necessary tools that are as well maintained as they can be; and third, material and supplies promptly delivered so that the workmen will not be required to lose time waiting for their helpers to obtain material from a storehouse inconveniently located, or have to hunt it themselves from the scrap pile, or rob other locomotives or cars in order to obtain it.

An important factor in obtaining shop output is properly scheduling the work through the shop so that the work of the various departments may be properly co-ordinated and in harmony. Scheduling will have a decided influence to keep everything moving and avoid delays due to one department waiting on another, and these schedules should not be interrupted from day to day by switching in jobs of running repairs which could perhaps be better performed in the roundhouse.

Locomotive schedules must be made very carefully. It is almost as much of a task to make out a proper schedule for locomotives through the shop as it is to make out a time card for a division. Schedules that work satisfactorily in one shop will no more apply to another than a time card for one division can be made to apply to another A schedule once made must be carefully followed, or one gang or machine will be crowded with more work to be done at one time than it is possible to accomplish without increased facilities.

Locomotive schedules bear the same relation to getting work through the shop that time cards do to getting trains over the line. Every possible effort should be made to live up to the schedule, but when something goes wrong, the dispatcher in the case of trains, or the general foreman in the case of the shop, must take a hand, make new meeting points, or devise new methods, hold some work back and advance other; in fact, take whatever action is necessary until the business is straightened out again.

It is no more possible to keep every engine in a big shop moving on schedule time than it is to keep every train between New York and Boston on time. If it is found that locomotives are continually behind schedule, it may be due to two causes: first, the schedule may be too fast; or second, something may be wrong in the shop that needs straightening out.

A schedule of any kind is of very little use unless some real and earnest effort is made to live up to it in the regular operation of the shop.

EQUIPMENT

The equipment of railroad shops is an important factor with respect both to efficiency and output. It is not efficient to continue in service machine tools which have long since outlived their usefulness. A few conditions noted on a trip over a railroad which operates about 1,500 locomotives will, perhaps, explain more clearly than any other method of discussing the situation, the conditions I have in mind which must be given attention if we are to reduce shop costs.

The principal shop is an old structure that has been added to from time to time, and has no modern facilities or crane service. Locomotive driving wheels are removed on drop pits in the shop. On account of the length of the shop, when removing wheels from 2-10-2 type locomotives, they are moved over a pit and spotted with the shop locomotive, and two pairs of driving wheels are removed. The locomotive is then taken out of the shop to the roundhouse turntable about 150 yards distant and turned around, returned to the shop, and the other three pairs of driving wheels are removed. To handle these wheels requires all the men that can get around them. In re-wheeling the locomotive the same process is followed; that is, three pairs of wheels are applied to the locomotive, it is then taken to the roundhouse turntable, turned around and returned to the shop so that the other two pairs of drivers may be applied.

At another shop on the same railroad, in checking the movement of parts of locomotives from the stripping pit, it was found that the driving boxes, rods, cross-heads, driver brake rigging, springs, hangers, etc., are trucked through the entire length of the shop to the lye vat, a distance of 700 feet, and then distributed to the respective places for repairs, and finally returned to the point they started from. This movement of material which is trucked through a congested shop could be eliminated by placing the lye vat at the stripping pit and in re-grouping some machines in the shop.

The driving boxes move 1,900 feet from the stripping pit until returned finished. This could be reduced to 400 feet by re-grouping the machines.

At various other points on the same railroad, we found repairs being made with the following obsolete machinery and equipment:

Wheel lathe which was installed in 1878 on which it requires seven hours to bore a driving wheel tire which could be done with a modern, heavy duty boring mill in 30 minutes.

Tender truck wheels being turned on a 36-in. engine lathe in which but one tire can be turned at a time; therefore, the operation is very expensive. It requires five hours to turn tires which on a modern, heavy duty wheel lathe could be turned in 30 minutes.

Crown brass turning machine, built in 1861, which is entirely unsuitable for doing this work.

Wheel lathe, date of installation not obtainable, but is very old and requires seven hours to turn one pair of driving wheel tires and six hours to turn one pair of engine or tender truck wheels.

Wheel lathe, old type, which requires six hours to turn one pair of 50-in. driving wheels, and four and one-half hours to turn tires on one pair of engine or tender truck wheels.

Wheel lathe, which was placed in the shop in 1879 and was second-hand at that time. On this machine, it requires from three and one-half to four hours to bore one driving wheel tire.

At another point locomotives are used to haul a transfer table, and this practice has been in existence for about six years.

Planers of different sizes, built in 1864 and in 1867. These machines have but one cross rail head and no side head, and are entirely unsuitable for present day requirements.

On a mountain railroad with over 100 locomotives, a large percentage of which are Mallets, there is no wheel lathe. Tires are removed from the wheel centers and turned on a boring mill, and when necessary to turn the journals, the wheels are pressed off the axles and the journals turned in an engine lathe.

This list could be added to either on this same railroad or by going to any one of a number of others where this is fairly representative of their shop conditions, and when we consider that these and other similar machines must be used to maintain some of the heaviest, modern locomotives now in service, we will realize what some of the mechanical departments are up against in their efforts to maintain equipment.

Modern appliances are an absolute necessity, and it seems a shame that some of the up-to-date shops should be filled with hopelessly back-number machinery. In such cases, aside from improved facilities for handling, no decrease in the cost of machine work and no adequate output can be expected, and a road with such equipment will require a greater investment in motive power and cars to handle the business. The principal question is not how many locomotives a road has, but how many good, serviceable locomotives, and this depends entirely upon the facilities which the road may have for repairing them and keeping them in service.

Next to the machine installation, it seems to me that the problem presented in shop operation which is most deserving of study is the question of transportation of parts;

traveling cranes, mono-rail runways and jib cranes are wonderful factors in efficient shop operation, as they expedite the delivery of material.

MANUFACTURE OF PARTS

It is usual for railroad shops to purchase some material and manufacture other. In some shops, the manufacturing of material is a large portion of the work done. In others, the material purchased much outweighs the material manufactured. Of course, shops, generally speaking, are repair plants and not manufacturing establishments; therefore, if we are to manufacture material or parts, I believe that a sharp line should be drawn as between material or parts to be purchased and material or parts to be manufactured, and having decided what is to be manufactured, those in charge of the shop should prepare to do it in an economical and efficient manner.

The railroads have not as a general rule organized their mechanical departments on a manufacturing basis, but have depended upon outside sources for the majority of their manufactured products and such shop facilities as they have maintained have been largely for repair and maintenance work. Because of the diversified products of the ordinary railroad repair shop of today, the question of production has not been given the consideration it has in other fields. On some railroads, a start has been made towards the introduction of manufacturing methods by the establishment of centralized shop facilities which act as manufacturing plants for such commodities as can be distributed to outlying points where facilities for economical manufacture are not maintained. Such work, however, has usually been carried on as a side line at the largest repair shops on the individual roads. On this basis, it has been found economical to install special machinery and methods at a centralized point and manufacture pieces in quantities for storehouse stock to be distributed on requisition to the smaller shops or terminals over the system.

It is hardly to be expected that in railroad work, it will be possible to introduce the methods used in automobile manufacture or kindred lines, but it should be quite possible profitably to produce parts used in sufficiently large quantities at a centralized shop or manufacturing plant. Inasmuch as the finished parts for locomotives and cars are not designed to be absolutely interchangeable either in design or manufacturing tolerances, it is necessary for the most part to provide sufficient latitude to permit of the final fitting of each piece at the point where application is to be made.

During the past few years, great improvement has been made and is being made in the design of machine tools and special machinery for railroad shop work. The installation of automatic and semi-automatic machinery adapted for railroad shop uses has been extended. The introduction of modern high capacity and special machinery into railroad shops has not always been an economical procedure, however, because of the fact that the output of the shop where installed has not been particularly adapted to the machinery, or because in the average shop such machinery can only be used a part of the time for the purpose to which it is particularly adapted. If parts are to be manufactured on a substantial scale, it could probably best be accomplished through the establishment of centralized manufacturing shops equipped with up-to-date machine tools and shop equipment, with particular attention to automatic and semi-automatic machines for the production of locomotive and car parts in quantities.

One of the most important factors in the successful operation of a centralized shop for manufacturing purposes is the relation between the mechanical and storehouse departments. In order to derive the maximum or even satisfactory results from such an organization, it is essential that the shop be organized for quantity production on requisitions originating with the stores department; otherwise, we would be apt to have duplication of unnecessary parts and an accumulation of expensive manufactured parts which represent obsolete designs and have no value other than scrap.

With increasing cost for material and labor, it will be necessary to reorganize railroad shop facilities with a view to keeping equipment maintenance costs within reason; therefore, modern methods of shop production should be applied to railroad work in a much greater degree than is prevalent today. Locomotives and cars should be looked at from the viewpoint of a large investment, the productivity of which increases in exact ratio to the percentage which is available for service. It is usually estimated that the locomotives on a railroad represent approximately eight per cent of the total cost of the property, but it is this eight per cent which makes the other 92 per cent profitable, so that even assuming that by suitable shop facilities and efficient shop operation we are able to reduce our percentage of unserviceable locomotives from 12 per cent to 10 per cent, we have done more than the percentage figures indicate, since the amount of transportation which can be furnished by any railroad is represented by the number of serviceable locomotives which it has.

STEEL CAR REPAIRS

While it is true that there has been failure in many instances on the part of railroads to provide locomotive shop facilities, the situation is even worse so far as steel freight cars are concerned, and with the exception of a very few railroads practically nothing has been done along the line of facilities for the repair of steel freight cars. Where these facilities are provided, they are, as a rule, of the most meagre character; frequently home-made furnaces, which result in extravagant consumption of fuel, totally inadequate equipment of clamps, formers, etc., worn out pneumatic tools, an insufficient supply of compressed air and, in a great many cases, actual shortage of repair material is found to exist.

Hundreds of thousands of rivets are being cut by hand which could be cut by proper pneumatic appliances in a fraction of the time. With proper buildings, proper equipment and a sincere and determined effort on the part of those responsible, the steel car plant can and should be as well organized and as efficient as any portion of our repair facilities. It can be made so only by presenting to the proper officers, a list of needs, clearly showing the saving which will result from their installation, and if they are installed, by making efficient use of them. The only locomotive and the only car that earns revenue is the serviceable one.

Do not understand this as a criticism of the men in charge of the mechanical departments on the various railroads, except as it may be considered a criticism of their failure more aggressively to urge that adequate facilities more promptly and economically to repair equipment be provided. Neither is it intended to make us dissatisfied with what we have, because all must realize that we must do the best we can with existing facilities, however poor they may be.

It is rather intended to be an outline of existing conditions and is given for the purpose of directing attention to the importance of formulating and following a definite and progressive policy of railroad shop improvement, because under the changed conditions which confront the railroads at the present time, with respect to labor costs, if we are to keep shop costs within reason, efficient and adequate facilities for doing the work in the way of improved shops and shop equipment, particularly machine tools, must be provided.

THE CASEHARDENING OF STEEL

Generation of Gases Necessary to Caseharden; Composition of Packing Materials Important

BY J. F. SPRINGER

II.[1]

Sulphur is an objectionable substance which may occur in packings containing charred leather. Coke would also be a source of sulphur. It seems, however, that whatever sulphides form during carburization are limited to positions on the surface and would often be cut away in a subsequent grinding operation. However, where grinding or some other machine operation is not contemplated it will be well to bear in mind this possibility of a damaged surface on casehardened objects.

We have, in the foregoing, reasons to watch our use of granulated bone and charred leather or leather meal.

One of the best packings is the following mixture:

Wood charcoal (powdered)..... 3 parts
Barium carbonate .... 2 parts

The action of this preparation is understood to be as follows: The wood charcoal itself acts upon the metal, and in addition, the charcoal acts on the barium carbonate, producing the gas carbon monoxide (CO). The present mixture is very suitable where it is desired to produce a thin layer of impregnated steel that shall be highly homogeneous. When the packing loses strength it may readily be regenerated by simply leaving it exposed to the air in a thin layer after having recovered it from the boxes. The reason that this regeneration is possible is that the atmosphere always contains carbon dioxide (CO_2) in small percentages. When the barium carbonate ($BaCO_3$) is decomposed during carburization, barium oxide (BaO) is formed. Upon exposure to the air this barium oxide absorbs carbon dioxide and is accordingly transformed into barium carbonate again. *

$BaO+CO_2=BaCO_3$.

Barium carbonate is readily obtainable, in normal times, at prices in the neighborhood of five or six cents per pound. This should be sufficiently pure for carburizing purposes. Again, the natural form of barium carbonate, known as witherite and obtainable in crystalline, granular or columnar masses, may be substituted for the powder form of the artificially prepared substance. However, if the natural witherite be used, it is first to be ground and then mixed with the charcoal. If the artificial product is employed, the white powder may be mixed directly with the granulated charcoal and the mixture then ground to a powdered form. Barium carbonate, whether artificial or natural, is a poison, consequently, care should be taken in handling it.

It will be pertinent to reproduce here some experimental results, originally obtained it seems by the investigator Guillet. He varied the proportions of wood charcoal and barium carbonate, using 4:1, 3:2 and 2:3 mixtures. The steel was a very soft article, containing only about 0.03 per cent of carbon. The period of carburization was eight hours and the temperature 1832 deg. F. Two layers each 0.01 in. thick were analyzed and the local percentages of carbon ascertained. The following table gives the results.

CARBURIZING EFFECTS OF MIXTURES OF WOOD, CHARCOAL AND BARIUM CARBONATE

Proportions		Carbon percentages	
Wood charcoal	Barium carbonate	External layer	Inner layer
4	1	1.14	0.75
3	2	1.32	1.19
2	3	0.94	0.77

I do not know whether Guillet previously heated the wood charcoal or not. There is reason to suppose, however, from experiments made by Nolly and Veyret that this preheating of the charcoal results in the more active production of carbon monoxide during the carburizing process, especially when the temperatures are high.

It may be as well to pause here and get a good glimpse of the carburizing action as now understood in the world of scientific research.

It is understood that a casehardening material acts though the gases emanating from it. Carbon alone will caseharden iron—but in a manner and to an extent that are of interest only to laboratory workers. Solid material operating without any assistance from gases has, from the point of view of actual practice, no effect. As we are, at present, interested only in practical matters, we note that the rule for us is: *Apart from the generation of gases, there will be no casehardening results.*

Further, in commercial work, it is understood that the gases do not act as mere carriers of carbon; or, if so, then only to a small extent. It is rather understood that the carburizing gas—which contains within itself the carbon—decomposes partially when it comes into contact with the highly heated metal. The carbon set free is absorbed by the metal, and the gas penetrates into the interior and there continues to decompose. This sets free additional carbon which is absorbed by the adjacent metal.

In actual practice, then, a substance must be supplied which when heated is capable of generating one or more carbonaceous gases and these gases must decompose as they penetrate into the interior of the metal.

Take the case of the packing material consisting of a mixture of pulverized wood charcoal and of pulverized barium carbonate. We are to understand that the solid wood charcoal exercises little or no direct influence on the metal. The heat has the effect of decomposing the barium carbonate ($BaCO_3$) into barium oxide (BaO) and carbon dioxide (CO_2). Here the carbon has only half as many atoms as the oxygen. Carbon in the form of wood charcoal enters into chemical combination with the carbon dioxide. The result is a gas in which there are as many atoms of carbon as of oxygen. This is carbon monoxide (CO). It is the real carburizing agent. As it comes into contact with the highly heated steel it seems partially to decompose and partially to go further in. As it gets in further, more of it decomposes, and so on. When carbon monoxide decomposes, free oxygen and free carbon are the result. Just what becomes of the oxygen, I do not know. The carbon enters into combination with the iron and forms iron carbide. There can hardly be any doubt but that this is substantially what takes place. This iron carbide is the cementite of the newly produced steel.

It will now perhaps not be difficult to understand that

[1] The first part of this article appeared in the November issue of this publication.

*During carburization, free carbon is present in the form of the wood charcoal. When the barium carbonate decomposes, the C and O_2 or else CO_2 given off is converted by this charcoal carbon into carbon monoxide. This gas is a powerful carburizing agent and is understood to be active upon the metal when the charcoal-barium-carbonate method is employed.

it is a matter of importance to know the gases which are given off by proposed packing materials and the relative amounts of carbon monoxide and similar gases.

Take wood charcoal for example. Between shop temperature and, say, 572 deg. F., the following gases will be evolved—carbon dioxide (CO_2), oxygen (O), carbon monoxide (CO), hydrogen (H), methane (CH_4) and nitrogen (N). These temperatures are entirely too low for carburization. Besides, the only gases produced in considerable percentages are CO_2, O and N. When the temperature of the wood charcoal has, however, been brought up, say, to 1,562 deg., F., the case will be somewhat different. Hydrogen becomes the principal product, but there is now increased relative amounts of CO and CH_4. Carrying the temperature on up to say to 1,922 deg., F., H. and CO become the principal gases evolved, the hydrogen predominating. That is to say, the CO now evolved amounts to about 20 per cent of the total being given off, while hydrogen amounts to some 73 or 74 per cent.

In short, the true agent of carburization (CO) is evolved, when the temperatures get up to casehardening levels, in very moderate relative amounts. Hydrogen is the plentiful gas. Even if we count CO and CH_4 both, for the temperature 1,562 deg., the combined percentage is only 21.3. At 1,922 deg., CH_4 is scarcely coming off at all. It should perhaps not be difficult to understand, after this disclosure, that wood charcoal alone is not much of a casehardening agent. It doesn't produce the thing wanted in sufficiently great relative amounts.

Suppose, now, we consider a table exhibiting at the temperatures 1,562 and 1,922 (fair limits for the casehardening range) the relative amounts of CO, H and CH_4 evolved by various combinations of wood charcoal and barium carbonate. Combinations 4 and 5 are understood to be identical with 2 and 3, respectively, except that in 4 and 5, the wood charcoal has been previously heated to about the boiling point of water (212 deg., F.).

RELATIVE VOLUMES OF CASES GIVEN OFF BY MIXTURES OF WOOD CHARCOAL AND BARIUM CARBONATE

Temperature		No. 1 Wood charcoal 90% $BaCO_3$10% Per cent	No. 2 Wood charcoal 70% $BaCO_3$30% Per cent	No. 3 Wood charcoal 50% $BaCO_3$50% Per cent	No. 4 Wood charcoal 70% $BaCO_3$30% Per cent	No. 5 Wood charcoal 50% $BaCO_3$50% Per cent
1562° F...	CO	28.1	25.3	30.8	42.2	28.4
	H	52.8	57.7	53.4	20.0	37.0
	CH_4 ...	8.7	8.7	7.0	2.0	1.2
1922° F...	CO	37.3	56 1	63.8	71.7	75.2
	H	60.0	32.0	28.0	15.0	12.0
	CH_4 ...	0.9	0.9	0.8	0.7	0.8

These results are understood to have been obtained by Nolly and Veyret. The percentage of CO given off at 1,562 deg. F., by the 50-50 mixture, the charcoal having been heated, seems anomalous. The loss due to the preliminary heating would be insufficient to account for the figures 28.4. Aside from this, the table shows pretty satisfactorily that the higher the percentage of barium carbonate, up to 50, the greater the relative amount of CO given off. The table also shows the considerable increases in relative amounts due to higher temperatures. Further, the preliminary heating of the charcoal appears to be beneficial. It is to be borne in mind that the percentages do not tell us the relative amounts of gases as between one temperature and the other, nor do they tell us the comparative amounts from different mixtures at the same temperature. They do tell us the relative amounts of various gases given off by one mixture at one temperature.

It will be well then to have before us in tabular form the relative total volumes of gases given off. Presumably these figures are comparable, for these total volumes, whether we attend to the rise of temperature for a single mixture, or whether, for a single temperature, we pass from one mixture to another. This data is also understood to be due to the same investigators.

RELATIVE VOLUMES OF GASES SET FREE FROM MIXTURES OF WOOD CHARCOAL AND BARIUM CARBONATE

Mean temperature	No. 1 Wood charcoal 90% $BaCO_3$10%	No. 2 Wood charcoal 70% $BaCO_3$30%	No. 3 Wood charcoal 50% $BaCO_3$50%	No. 4 Wood charcoal 70% $BaCO_3$30%	No. 5 Wood charcoal 50% $BaCO_3$50%
1472° F.	125	78	80	25	40
1652° F.	198	129	69	36	34
1832° F.	180	63	78	70	115

The following is a very simple mixture which appears to have given very satisfactory results. It seems to be superior to simple wood charcoal, but is scarcely the fine casehardening packing that the 3:2 mixture of powdered wood charcoal and barium carbonate is.

Wood charcoal	9 parts
Common salt	1 part

As to the apparent superiority over simple wood charcoal, one authority says: "for this it is not easy to give a scientific reason."

Other mixtures are:

I

Pulverized wood charcoal (oak)....	5 parts
Pulverized leather charcoal.........	2 parts
Lamp black	3 parts

II

Pulverized wood charcoal (beech)...	3 parts
Pulverized horn charcoal...........	2 parts
Pulverized animal charcoal.........	2 parts

The authority Grenet is understood to recommend the following three recipes, all parts by weight:

I

Pulverized wood charcoal.........	10 parts
Common salt	1 part
Sawdust	15 parts

II

Coal (having 30% volatiles), pulverized	5 parts
Charred leather, pulverized........	5 parts
Common salt	1 part
Sawdust	15 parts

III

Charred leather, pulverized........	5 parts
Yellow prussiate of potash........	1 part
Sawdust	5 parts

The rapidity of carburizing action is understood to increase from the first to the third of these mixtures. The sawdust is supposed to be advantageous because it makes the packing porous and consequently easily penetrable by the gases.

It will be well, I think, to quote some remarks by an authority on casehardening: "As I have already said, there are in use in machine shops numerous mixtures of the most varied and complex composition. The results of accurate and precise experiments do not justify, however, the use of such complex mixtures, which do not furnish results superior to those which are obtained with the less complicated cements; and, further, because of their complexity, do not furnish results which are constant or uniform and can be exactly predicted. The best and surest results are always obtained by using the simplest cements."

THE DAMAGED INTERIOR

The casehardening process is carried out within the range, say, of 1,472-2,012 deg., F. As the temperature level at which grain enlargement begins is 1,274 deg., it will be seen that the process necessarily involves over-heating and the consequent damage. There are, in general practice, two remedies for grain-enlargement—mechanical working, and re-heating. Naturally, the mechanical cure will practically never be available in cases where the exterior is casehardened. This leaves us with the heat-treatment proce-

dure. One great advantage that the heat-treatment method has over the mechanical consists in its penetrative power. This, in ordinary practice, is often sufficient to make it preferable. Here, where no choice is permitted, the same advantage naturally obtains. Heat goes everywhere—into the interior, into big and small parts, etc., carrying its beneficial effects with it. On the other hand, the restoration of overheated steel by heat treatment is not equally successful with all the varieties of carbon steel. It is doubtless at its maximum of success when the carbon content is around 0.90 per cent. The steels generally used in work that is to be casehardened have carbon contents that are much below this figure. Probably the great majority have carbon percentages below 0.40 per cent. These are not the varieties of carbon steel that one would choose in order to display the effects of restoration by heat treatment. The reason is this. The annealing point for such steels runs up to temperatures considerably above 1,274 deg. These temperatures are to be attained, and yet every degree above 1,274 means further grain enlargement. Still, one has to deal with facts and not with wishes. While the restoration is not ideal, it is the thing to apply, because there is nothing else.

After the operation of carburizing has been completed, the work must be cooled below 1,274 deg. (medium cherry red), before applying the heat treatment. This is an essential point. There is a question, however, as to whether it should be cooled slowly or suddenly, and to this I will return later. Just now, let us master the essential point that the cooling must go below 1,274 deg. It matters not how far below 1,274 the cooling proceeds—the important thing is that it drops below. A black heat is good, especially as a black outside probably means—except for heavy work—an inside cool enough. Naturally, it is necessary that the interior as well as the outside cools off enough. Work made to cool down to shop temperature will certainly be all right, although this may seem a useless waste of heat, since the work is to be reheated.

But there is really no waste, or but little, for the reason that it is approved practice not to cool the work off slowly from the carburization point but rapidly. That is, the work is quenched. There is a partial exception to this. If the work has been carburized at a very high temperature (1,922-2,012 deg. F.), then it will be well to permit a slow cooling, say to 1,740-1,800 deg. and then carry out the quenching. The objection to the slow-cooling from the carburizing temperature centers on the possibility of the liquation of the ferrite and perhaps of the cementite as well, if the cooling is slow.

If there is any tendency to cracking, oil may be substituted for water as a quenching medium. Indeed, hot oil—with a temperature as high as 200 or 250 deg. F. — may be used and a still better correction realized.

There is still another quenching operation. This is the one which produces the hardening effect on the external shell. It is properly carried out at a temperature slightly in excess of 1,274 deg. — that is, at a full cherry red. Hardening can be done at higher temperatures, but why run the risks? The best practice everywhere in respect to the hardening of tool steel—and that is the kind of steel in the shell—prescribes hardening at a low temperature. However, Giolitti seems to sanction a hardening temperature for casehardening as high as about 1,470 deg. Whatever temperature is decided on, note particularly that it is not necessary that the interior be at this temperature. It is only the external shell that will be sensibly affected as to hardness by the operation now in hand, because that is the only part containing a high percentage of carbon. But, it is important that the surface heat desired shall exist everywhere. This is sufficiently obvious, once it is stated.

As to the choice of the exact temperature, it may be necessary to do a little experimenting. This is a very good rule to keep in mind when reading any statements as to the proper temperatures for all kinds of heat treatment operations. There are so many factors at work and these factors are so often variable that rigid statements that a metal will do thus and thus precisely at such and such temperatures are hardly permissible. The results may have been realized once with a certain piece of metal. The next piece that is tried may refuse to act as expected at precisely the temperature named; but may do so at a point a little higher or a little lower. The quenching having been carried out, one may then or later apply the heat treatment. This consists in heating to the annealing point proper for the carbon content, making sure that this heat has penetrated everywhere that restoration is desired, and then quenching the work. There will be more or less reduction of the grain size. The amount of this reduction will, it is understood, depend upon the maximum temperature of the re-heat. The more moderate it is, other things being equal, the greater the reduction to be expected.

The temperature of restoration for steels having carbon contents between 0.00 and 0.50 per cent may be taken to vary between 1,675 deg., F., and 1,425 deg. This is a temperature range of 250 deg. to be divided along 50 points of carbon variation. One readily gets the rule: *For every carbon point above zero, subtract 5 degrees of temperature from 1675 deg.* Thus if the carbon content is 0.08, subtract from 1,675 the product of eight and five, getting 1,635 as the temperature for the maximum of the reheat. If the steel be one having 0.20 per cent of carbon, subtract 20 x 5 giving 1,575 as the right temperature at which to stop the re-heating. Manifestly, if the case permits, we should choose a stock having as high a carbon content as would be available for the reason that it requires a lower re-heating temperature upon the re-heat, and this lower temperature is an advantage in the success of restoration. This is a matter that is probably very generally overlooked, since the eagerness to get a steel easily machined drives the choice to low carbon contents. The natural hardness of steel, not that produced by quenching, varies with the carbon content—the more carbon, the harder the steel. The choice of steel, however, should depend more upon the effectiveness of the restoration of quality than upon the ease of machining. In general, then, one should select as high a carbon content as is permissible, all things taken into consideration.

Having settled on the proper temperature for the restoration of the heart of the carburized steel in hand, the work is heated very slowly to the proper point. It is sometimes found that the restoration has to be carried out by heating to still higher points than those given and then quenching. This seems to be especially the case with steel of a very low carbon content. Thus, A. Portevin states that it is often advisable to quench from as high a temperature as 1,832 deg. F., "since the transformation into gamma-iron, which destroys the grain, is subject to retardations, like all polymorphic transformations."

THE TEMPERATURE OF CASEHARDENING

The choice and control of the temperature at which the casehardening procedure is carried out constitutes one of the vital items of a proper technique.

Comparatively recent investigations show that the temperature of carburization affects both the rate of carbon penetration and the depth of such penetration. Martin-Siemens steel of low carbon content was employed in the form of square bars 1.6 in. by 1.6 in. in section and eight inches long. The particular packing material consisted of pulverized wood charcoal that had been treated with five per cent of potassium ferrocyanide and then mixed with an equal weight of barium carbonate in a dry condition. This may be regarded as substantially a half-and-half mixture of charcoal and car-

bonate. The following table and the accompanying curves exhibit the results:

EFFECTS OF TEMPERATURE ON DEPTH AND RATE OF PENETRATION

Number of hours in casehardening period	Penetrations in inches corresponding to temperatures				
	About 1292° F.	About 1382°-1436° F.	About 1562°-1652° F.	About 1742°-1832° F.	Above 1832° F.
12	0.030	0.044	0.078	0.098	0.106
24	.046	.064	.114	.148	.160
36	.060	.090	.146	.204	.232
48	.076	.112	.180	.236	.292
60	.088	.126	.212	.280	.338
72	.102	.144	.236	.312	....
84	.112	.158	.270	.348	....
96	.120	.180	.298	....	....
108	.132	,198	.324	....	....
120	.138	.218	.350	....	....

Referring to the curves, it will be seen at once that they do not cross one another. Each is altogether above the ones belonging to lower temperatures.

This means that when the temperature of casehardening is raised, the effect is to get a greater depth of penetration whatever the length of the period. This is a good general rule to remember. Again, splendid results, comparatively,

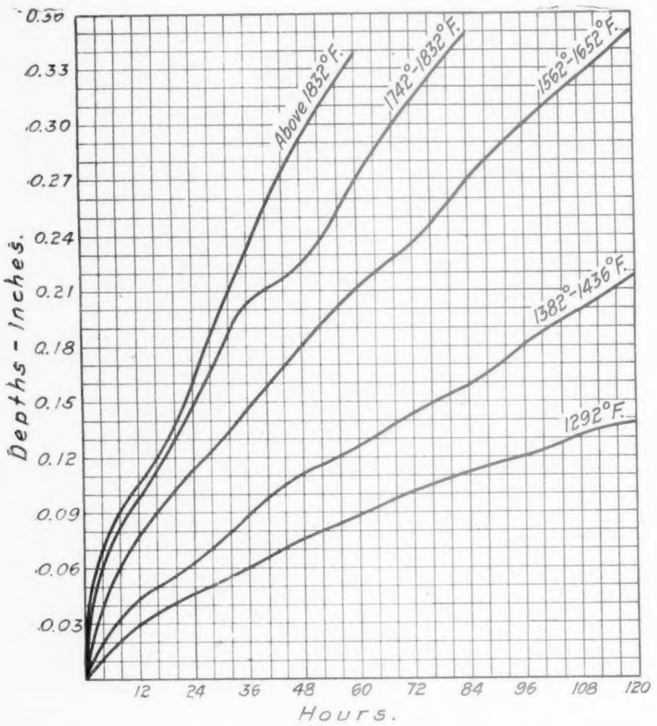


Chart Showing Relation of Time and Temperature to Depth of Impregnation

may be gotten with the temperature 1,562-1,652 deg. For general work, then, this is a good casehardening temperature. Raising the temperature quickens results, but except in special cases, hardly enough to warrant the practice. Good results are obtainable at temperatures below 1,562°-1,652°, so that, if there is need to use them, one may still expect results in a reasonable time.

Note especially that the curves are substantially straight lines. This means that the depth of penetration, at any given temperature of casehardening, is practically proportional to the length of the period. The simplicity of this rule gives it great practical value. If penetration to double the depth is wanted, then double the time will be required; if three times the depth, then three times the period, and so on.

DISTRIBUTION OF CARBON

It is of service to know the distribution of the carbon in the casehardened shell. Naturally, the local percentage of carbon falls off as the depth increases. Experiments have been tried for the purpose of getting at these facts. Probably, each packing material and each temperature of casehardening will affect this matter. Also, the period, the pressure inside the box, etc., will influence the distribution of carbon. It will, nevertheless, be useful to have some representative results before us: The packing material consisted of a mixture of wood and animal charcoal in the proportions of 7:3; the steel was a very low carbon variety (0.05 per cent); the carbon content of successive layers was determined after casehardening for 36 hours at 1,562-1,616 deg. F. The first layer was 0.2 in. thick; the following ones, 0.04 in. each. The carbon percentages for 12 layers, having a total thickness of 0.460 in. were as follows:

1.02, 1.00, 0.94, 0.66, 0.43, 0.22, 0.16, 0.14, 0.12, 0.10, 0.08, 0.07.

It will be noticed that the percentage of carbon in the steel fell off rapidly. This is, in fact, generally characteristic of casehardening. The high carbon steel is all located in a thin shell at the surface. However, by prolonging the period, tool steel (say, steel having more than 0.80 per cent carbon) may be produced to a pretty good depth. In the present case, the 0.80 per cent mark was reached at a depth of about 0.12 in.

It will be of interest to compare this with the results obtained on the same steel at the same temperature when the period was lengthened out to 10 times the original length—that is, to 15 days of 24 hours each. The carbon percentages follow, but the layers are, except for the first 0.02 in. of double thickness to what they were before. If one wishes to compare these results with the former, the missing percentages may be inserted. They may, in each case, be taken as the average of the pair between which the percentage is to have its place. They are as follows:

1.01, 0.95, 0.90, 0.85, 0.79, 0.73, 0.67, 0.62, 0.57, 0.52, 0.47, 0.43, 0.37, 0.33, 0.28, 0.25, 0.22, 0.18, 0.17, 0.15, 0.14.

The total depth of penetration here involved is 1.62 inches. If a curve be formed, it will be found to approach somewhat to a straight line. A curve for the former results (corresponding to 36 hours) would differ very considerably from such a line. This suggests the principle that the concentration of carbon falls off with a greater approach to regularity, the longer the period of casehardening. In the case of the 360-hour period, the increase of the depth by 0.08 meant, in the earlier part, a drop of five or six points in the carbon percentage.

In view of what is now known about casehardening, it seems permissible to state that, if the temperature is maintained at one level throughout the casehardening period, then he may with confidence expect that there will be no abrupt variations in the concentrations of carbon as the process penetrates from the outside towards the center. The rate of change may not remain the same, but it will not alter suddenly. This is a very important thing, since it enables us to avoid producing a shell or layer very distinctly different from the next above or the next below. Generally, abrupt changes in the carbon content of the steel are not desirable. All that we have to do is to maintain the conditions, especially the temperature, throughout the casehardening period.

CONTROL OF TEMPERATURE

Control of temperature—holding it at a given level—is much more easily specified than accomplished. A proper furnace is necessary and it must be capable not merely of producing the required temperature but it must provide a heating space where the fluctuations of temperature, as to various locations, are very slight. Good casehardening can hardly be done if the variations in temperature in different parts of the furnace—except, perhaps, for a space near the door, or some other special spot—are considerable.

Giolitti sets a maximum permissible variation at 30 deg. C. This is 54 deg. F. I will venture to say that there are any number of furnaces where this requirement is not met and where nevertheless casehardening, after a fashion, is being done. This evenness of temperature in the heat chamber is doubtless difficult to get where solid fuel is used, but a properly constructed furnace operated by oil or gas should accomplish the desired result.

A second prime requirement of the furnace is the capability of being run for long periods of time—up to 100 or more hours, depending upon the work—at the same temperature. This is another requirement that the furnace fired with solid fuel will probably find it difficult to satisfy. Oil and gas, however, when used in properly designed and constructed furnaces lend themselves to accurate regulation and should satisfy the requirement for an extended run.

A REPRESENTATIVE PROCEDURE

It will be useful to summarize for a representative case a good deal of what has been set forth. Let us assume that we have to caseharden a lot of small articles of low carbon steel.

1. Prepare the packing, making sure of its purity, fineness and dryness.
2. Prepare the box by casting the bottom with a fire-clay paste.
3. Heat the box or otherwise provide for drying this paste.
4. Tamp in place a bottom layer of packing 1½ in. thick.
5. Place one layer of the work on top of this layer, making sure that minimum space between articles and between the articles and sides of the box is 1½ in. or 1¼ in.
6. Put packing in and around articles and overlay them until the minimum depth of packing above tops of articles is 1½ in. or 1¼ in. Tamp the packing in place.
7. Repeat five and six for each layer of work put in.
8. Add a top layer of tamped packing to a depth of at least 1¼ in. or 1½ in.
9. Put top on, luting it with mortar of fire clay and water.
10. Set box, thus loaded, in furnace, but near door, until the interior moisture is all gone and the fire clay seal is dry.
11. Push the box into the furnace and bring temperature of boxes and contents to about 1,600 deg. F. There will be a variation between the center of the box and the exterior; 1,650 outside may be needed to get 1,600 inside near the center.
12. Maintain heat at an even level for the necessary time.
13. Remove box from furnace, open and suitably quench.
14. Re-heat slowly to restoration point.
15. Quench again.
16. Re-heat to proper hardening point.
17. Quench.

LOCOMOTIVE FAILURES

BY J. F. DONELLON
Master Mechanic, Delaware & Hudson

Locomotive failures, that awful nightmare to every conscientious roundhouse foreman, general foreman and master mechanic, can be given a knockout blow by applying the proper remedy in the roundhouse. If they cannot be eliminated entirely, they can be decreased to such an extent that the superintendent of motive power will wonder what happened.

This is what should happen: Cover the most important jobs in the roundhouse with specialists. The more specialists, the more efficient the organization will be. No matter how poor a mechanic a man may be, if he is interested in his work, he is bound to become more proficient if given regular work on a locomotive or machine. With the eight-hour day in effect and mechanics being paid while they eat, it is not asking too much to insist on 100 per cent efficiency.

It would be well for any master mechanic or shop superintendent to pattern his shop organization after a winning ball team—the master mechanic should be a good live manager, the general foreman or enginehouse foreman the captain, the gang foreman or leaders to be the coaches, training the players thoroughly, encouraging them when they are slipping and cheering them when they make a home run, or in other words when they do a good quick job.

Post the locomotive failure sheet, which in reality is a score board, every day. They will then quickly learn the items that cause failures and they will feel their pride hurt when fellow employees refer to some locomotive they worked on as failing between terminals and delaying other trains.

A careful analysis of the monthly failure sheet on any railroad will shown that 90 per cent of the failures are caused by improper inspection in the shops. Too much stress cannot be laid on the practice of educating locomotive inspectors, calling their attention to items that cause failures and giving them breakage diagrams of all the parts that fail, regardless of whether the locomotive on which the failure occurred was out of their respective station or some other station.

It is my belief that every rod, frame, link hanger, or in fact, any of the particular parts that fail frequently, have what I consider a breaking zone; that is, some part of the rod stands considerable more stress than the other sections and is more liable to fail.

A list of the parts that failed and caused locomotive failures on a prominent railroad is given below:

Air pump	4
Axle (driver) broken	2
Brake beam down (driver)	[illegible]
Brass broken (tank)	[illegible]
Bolts, eccentric hook gone	1
Brace, tank binder broken	1
Bolt, front side rod broken	1
Bolt, lost out back end of valve rod	3
Link saddle bolts broken	1
Rocker arm bolt lost	1
Cylinder head broken	2
Cylinder packing	2
Firebox door	1
Drawbars broken	1
Flues, superheater, leaking	2
Flues, bursted	4
Dump grates disconnected	1
Guide yokes broken	1
Leaky tank hose	1
Spring hanger broken	2
Driver hub cracked	1
Transmitter bar broken	2
Tender brake beam hanger broken	1
Link block hanger broken	1
Injectors not working	2
Hot tender truck journals	2
Hot trailer truck journals	1
Hot driver axle journals	7
Hot engine truck journals	3
Lining, front end main rod keys	1
Main rod key lost	1
Nuts off guide	2
Hot main pins	5
Broken air pipe	5
Packing rings, valve	1
Piston head broken	1
Plug out of release valve	1
Main rod working loose	1
Intermediate rod broken	2
Bolt blown out, reservoir	1
Reverse gear in back motion	1
Reverse lever casting broken	1
Low steam	2
Low steam due to leaky flues	1
Main rod strap broken	1
Relief valve spring broken	1
Strap on drawbar down	1
Tires loose	4
Throttle connection broken	1
Valve stem broken	1
Wrist pin nut lost off	1

This list extends over a period from January 1 to August 1, 1919. On this particular division there were 38,000 en-

gines dispatched during this time, including yard engines and all classes of power, so there were approximately 430 engines dispatched per engine failure.

A careful study of the causes of failures, both by the mechanics and the inspectors, will add greatly to the capacity and efficiency of the roundhouse organization.

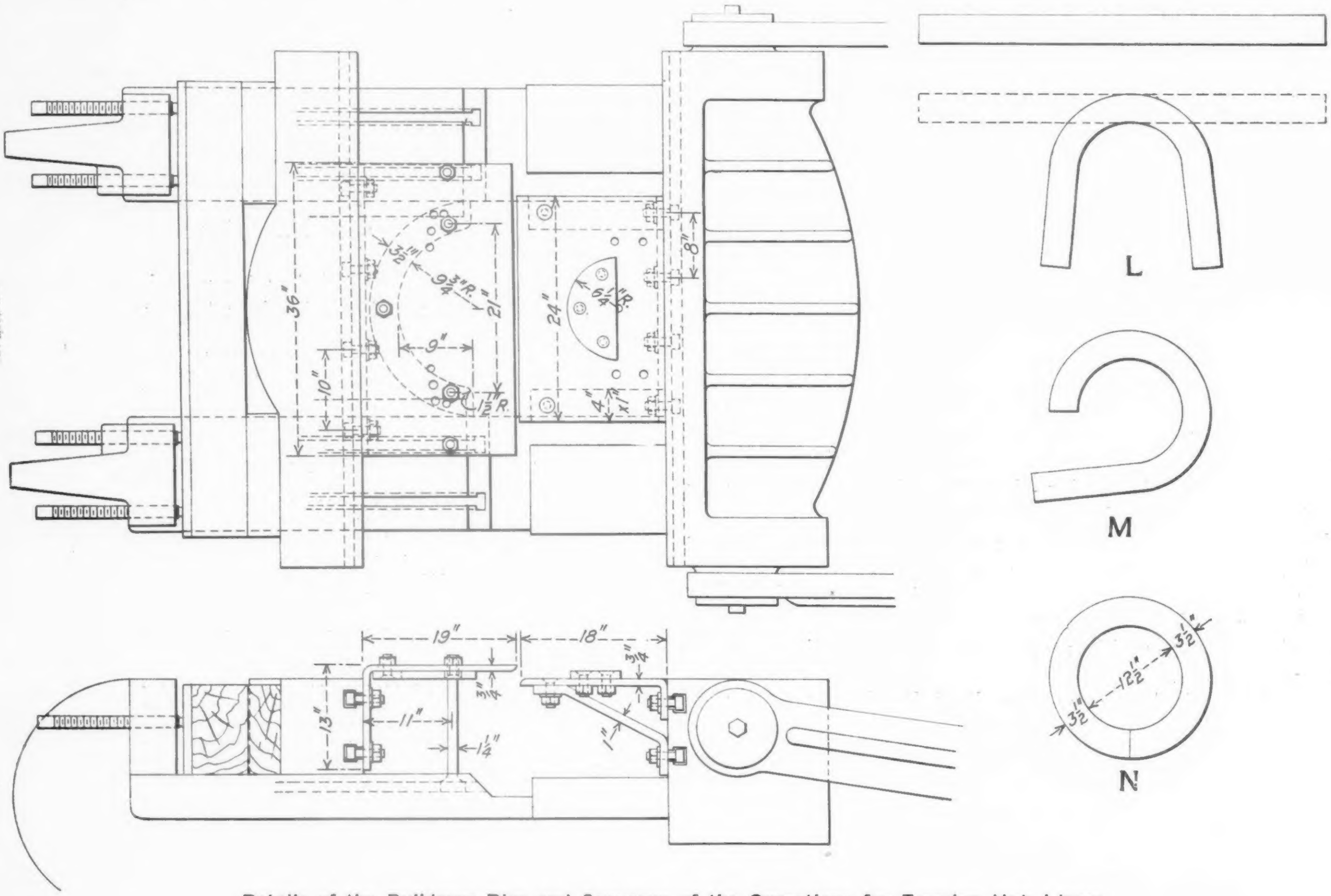
FORMING HUB LINERS ON THE BULLDOZER

BY F. G. LISTER

Mechanical Engineer, El Paso & Southwestern, El Paso, Tex.

On the El Paso & Southwestern there has been in use for some time a device for forming wrought iron hub liners for locomotive driving wheels on the bulldozer. This has proved very satisfactory as it forms a good hub liner at a very nominal cost. The device as applied to the machine is shown in the drawing. The dies *A* and *B* are made to correspond to the inside and outside diameters respectively of the hub liners, *A* being bolted to the top of one plate and *B* being bolted to the bottom of the other.

To form the liner, a piece of wrought iron 1 in. by 3½ in. and of the proper length to make a full circle is brought to a cherry red heat and laid across the bottom plate and against the periphery of die *A*. The first stroke of the bulldozer forms a piece similar to the shape shown at *L*. The iron is then moved until the center of the die is about one-fourth the distance from the end, and the second stroke of the bulldozer forms it to the shape shown at *M*. A similar operation on the opposite end at the third stroke forms the iron almost circular as shown at *N*. It is turned several times on the plate until a perfect circle is obtained and the ends join well together. The dies *A* and *B* are bolted to the plates ⅞-in. countersunk head bolts, so that they may be removed and other dies having different radii, depending on the diameter of the hub liner required, may be applied in their place.



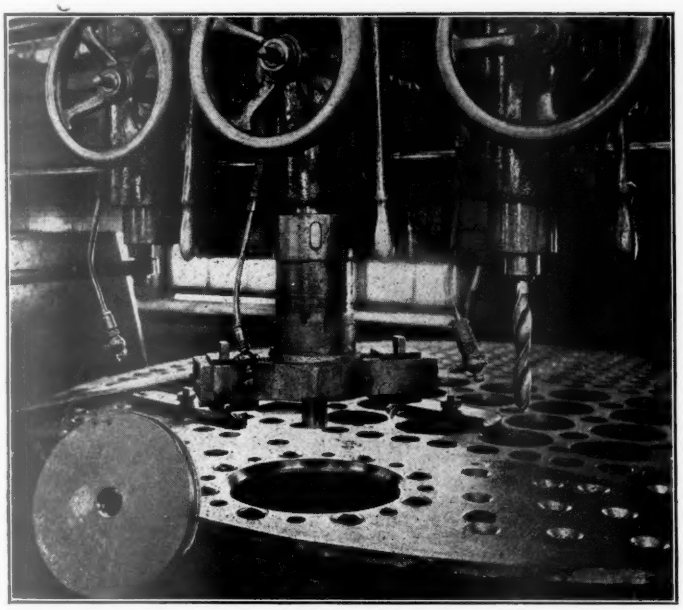
Details of the Bulldozer Dies and Sequence of the Operations for Forming Hub Liners

Corn Used as Fuel in Argentina.—Because of the impossibility of securing coal from England, from which country Argentina formerly imported its supply, according to an article in the Railway Gazette (London), the demand for hard wood, obtained from forests in the northern part of the country, grew so rapidly that the railways found it difficult to haul to the south sufficient wood to supply themselves and other consumers. Experiments were then made with corn (maize), of which there was an abundance in the republic, and it was found that maize would burn freely and had practically the same calorific value as hard wood. It gave good results in the stationary boilers of power houses where thousands of tons were burned each month. Some was also used in locomotives. It was burned sometimes in the form of grain, but more often on the cob. Firebars had to be placed about ½ in. apart, otherwise the grain fell through into the ash pit or ash pan. This closing up of the bars was particularly necessary when maize was used on locomotives. In such cases it was burned mostly on shunting engines. The relative calorific values of maize and coal are found to be in practice as 2.5 to 1; similar values for hard wood and coal vary between 2.1 of wood to 1 of coal, and 2.5 of wood to 1 of coal. If the maize is ground down until the particles are about the size of those of a medium sand, and it is then blown by a fan into a heated combustion chamber, it immediately bursts into flame and is much more economically consumed. The maize sold for about $15 a ton and a large quantity is still being burned in the Argentine, but fuel oil in reasonable quantities is now arriving from the Mexican and other oil fields.

CUTTING DRY PIPE HOLES IN TUBE SHEETS

BY J. J. SHEEHAN
Tool Foreman, Norfolk & Western, Roanoke, Va.

The photograph herewith shows our method of drilling and facing front flue sheet for steam pipe joint. This tool



Tool for Cutting Dry Pipe Holes in Tube Sheets

fits the drill press spindle on the outside and is held in place by a key fitted to the drift slot in the spindle. The cutter heads are adjustable, having a range of boring size from 5 in. to 15 in. The size of steel used for tools is 5/8 in. by 1 in.

HOT DRIVING BOXES ON A. E. F. LOCOMOTIVES

BY C. E. LESTER
Shop Superintendent, Nevers (Nievre), France. Shops of the American Expeditionary Forces

In our repair work at the Nevers (Nievre), France, shops of the American Expeditionary Forces, among other things we experienced considerable trouble due to driving boxes running hot on one type of Consolidation locomotives immediately after leaving the shops after being overhauled. It was noticed that some 12 or 15 locomotives of this type had been sent to our shop within a few weeks' time to have the crown bearings renewed, and upon comparing the date of shopping and the date that the locomotives were built, it was found that they had been in active service only from one to three months.

When two or three of these locomotives had run hot after receiving new crown bearings, it was decided to watch the next one closely to determine the cause for this condition.

On the next locomotive received for repairs the driving boxes were removed, the crown bearings were shimmed, and in so doing several of them became out of parallel at the shoe and wedge face, making it necessary that these faces be planed. All the boxes were then bored to fit the journal, allowing enough to scrape them to a perfect bearing. The proper amount of clearance was given to the bottom ends of the crown bearings so that the oil would not have any difficulty in staying on the journal and that the box would not have a tendency to ride the journal.

In boring the boxes they were set on the boring mill on parallel strips with the hub face of the box up, to which they were lined with a surface gage so that the bore of the bearing would be at exactly right angles to the hub face. The boxes were then drilled and the bearings chipped, in order to have the oil from the oil cavity on top of the box distributed as evenly as possible over the entire surface of the crown.

The boxes were then sent to the erecting shop, applied to the journals, and checked by the erecting shop inspector, who found them anywhere from 1/16 in. to 5/16 in. out of center on the inside faces of the boxes. This condition existed on the boxes that had been planed, as well as on those that had not been planed, and on removing them from the journals and laying off a center on both the hub face as well as on the inside face of the box, it was found that the hub face was exactly in the center when compared with the shoe and wedge faces, but that the center on the inside face of the box was out of line the amounts stated above.

At this time we received in the machine shop another set of boxes of the same type, and before any work was done on them, centers were applied to both faces, as had been done to the other set, for the purpose of determining what their condition was when they were removed from the engine. It was found that these boxes also were out of center on the inside face of the box.

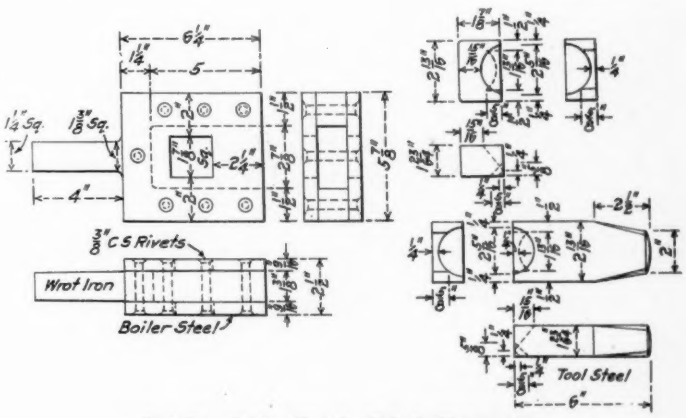
Previous to this time, when we had any of the boxes of this type in the shop to have the shoe and wedge faces planed, we clamped them down to the planer table on parallel strips applied under the shoe and wedge face, depending on which one was to be planed, which of course caused the box to be planed in the same manner as when it was placed on the planer, with the exception of having the faces running parallel lengthwise.

From the investigation made the opinion was formed that the hub face bore of the crown bearing and the shoe wedge faces were not square with each other when they were first built at the manufacturing works. This, we think, caused a twisting movement of the box, which had the same tendency to make the crown beating run hot as would a bearing with the crown bored tapering.

As we had no means of obtaining a casting of the proper dimensions to make a planer face plate on which the boxes could be clamped against the hub face, a large square was made, to which the boxes were set before planing the shoe and wedge face.

SHAPING THE ENDS OF TRACK CHISELS

In dressing track chisels the usual practice is to taper the cutting end under the hammer and term the edge to the



Details of the Track Chisel Sharpener

proper contour on a grinding wheel. This operation requires considerable time and unless care is taken the steel may be heated to such an extent that it cannot be tempered. In the Shoreham shops of the Minneapolis, St. Paul & Sault Ste.

Marie, an interesting device is in use which shapes the end of the chisel after it has been drawn down and makes grinding unnecessary. This combined shaper and sharpener is shown in the illustration herewith. It consists of a guide which fits on an anvil and holds two dies. The chisel after being drawn down under the hammer is inserted between the cutting edges of the dies and a single blow cuts off the end and shapes the edge. By this method considerable labor is saved and the danger of burning the steel on the grinding wheel is avoided.

A COVERED HOSE REEL

The covered hose reel shown in the illustration affords a simple and effective means of protecting fire hose from the elements and at the same time permitting easy access to the hose when it is necessary to use it.

The cover is made of sheet metal formed to cover the reel and the upper portion of the fire hose and is firmly secured to the reel standard, which can be permanently placed near a water hydrant.

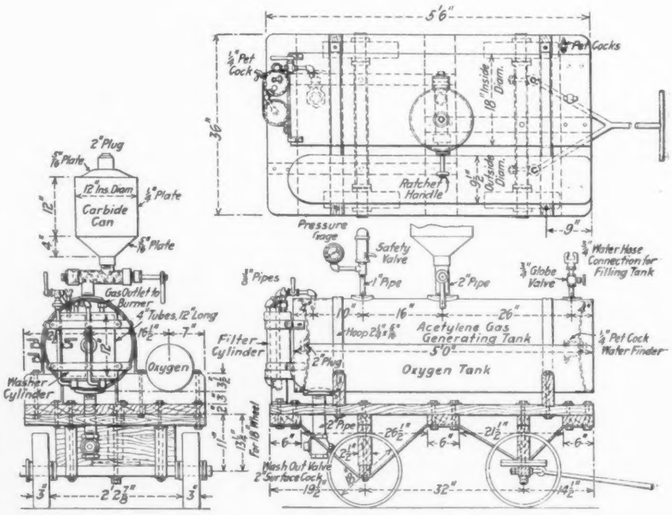
This cover can be easily and cheaply made in the shop

The Covered Reel Installed Near a Hydrant

and applied to hose reels about the yards. Its cost is not great and the protection afforded to the hose and to the reel itself will result in a much longer life of both. This effects an economy that will more than offset the cost of the cover and at the same time insures that snow or ice may not interfere with the use of the hose. This type of hose reel cover has been in use in the yards of an eastern railroad for some time past.

ACETYLENE GENERATOR, SACRAMENTO SHOPS, SOUTHERN PACIFIC

An old Pintsch gas tank or any other suitable tank that will hold a pressure of 50 lb. per sq. in. can be used for the generator. In generating gas the pressure should not exceed 12 lb. per sq. in. On the top of the generator is a reservoir to hold the carbide which is fed into the lower tank as wanted by a screw fitting in the inside of a two-inch pipe. The generating tank and washer should be kept about half full of water; the water level in the cylinders can be gaged by the use of pet cocks. The water level in the generator tanks should never be allowed to fall below the lower pet



Arrangement of Acetylene Generating Equipment

cock. The filter cylinder is to be filled with hair.

The gas from the generator tank enters the bottom of the washer cylinder, comes out of the top and enters the bottom of the filter cylinder from which it is drawn off through the hose and connections to the torch. Care should be taken to keep the carbide dry until used for making gas. At the end of the day, the generator tank should be washed out and fresh water put in both the tank and the washer cylinder. Every four months, or oftener if necessary, all plugs should be removed and the tank, pipes and cylinders should be given a thorough cleaning. No iron or metallic tools should be used in cleaning the tank. The contents should not be emptied into a sewer but should be deposited on the ground in some suitable location.

Diesel and Semi-Diesel Engines.—A Diesel engine is a prime mover actuated by the gases resulting from the combustion of a liquid or pulverized fuel injected in a fine state of sub-division into the engine cylinder at or about the conclusion of a compression stroke. The heat generated by the compression to a high temperature of air within the cylinder is the sole means of igniting the charge. The combustion of the charge proceeds at, or approximately at, constant pressure. A semi-Diesel engine is a prime mover actuated by the gases resulting from the combustion of a hydro-carbon oil. A charge of oil is injected in the form of a spray into a combustion space open to the cylinder of the engine at or about the time of maximum compression in the cylinder. The heat derived from an uncooled portion of the combustion chamber, together with the heat generated by the compression of air to a moderate temperature, ignites the charge. The combustion of the charge takes place at, or approximately at, constant volume.—*Compressed Air Magazine.*

NEW DEVICES

HIGH POWER TURRET LATHE

To meet the demand for a turret lathe of greater power and strength to finish gear blanks, forgings and tough alloy steel parts, the Warner & Swasey Company, Cleveland, Ohio, has developed the new No. 6 turret lathe, shown in Fig. 1. It is expected that on account of its increased power this machine will be able to do work formerly done by heavier and more expensive machines.

The increase in power and productive ability of the No. 6 turret lathe is secured by means of the double friction back gears, shown in Fig. 2. With the construction indicated, nine spindle speeds are available, three for each step of the driving cone. The extra power permits taking heavy forming and facing cuts on both bar and chucking jobs, which are beyond the capacity of the single back geared type of lathe.

The general view of the turret lathe shows it equipped with a heavy duty carriage provided with power cross and hand longitudinal feed. Six power cross feeds and reverse are obtainable in the apron. The three finer feeds are suitable for forming and the three coarser feeds for facing operations. The front toolpost, with an adjustable wedge, is arranged to be swiveled at any angle, and a cutting off tool holder is regularly furnished for the rear. Either of these tool holders may be removed and forming tool holders substituted. The automatic chuck and bar feed are provided, operated by a long lever in front of the head, and a stepped wedge automatically adjusts the collet for slightly varying diameters. A master collet and bushing pads are regularly furnished with the machine for holding 2¼-in. round stock, but bushings for hexagon stock can be held in this collet also. Square stock requires a square stock master collet and bushing pads. Extra capacity collets can be furnished for holding short-length work larger in diameter than the capacity through the spindle.

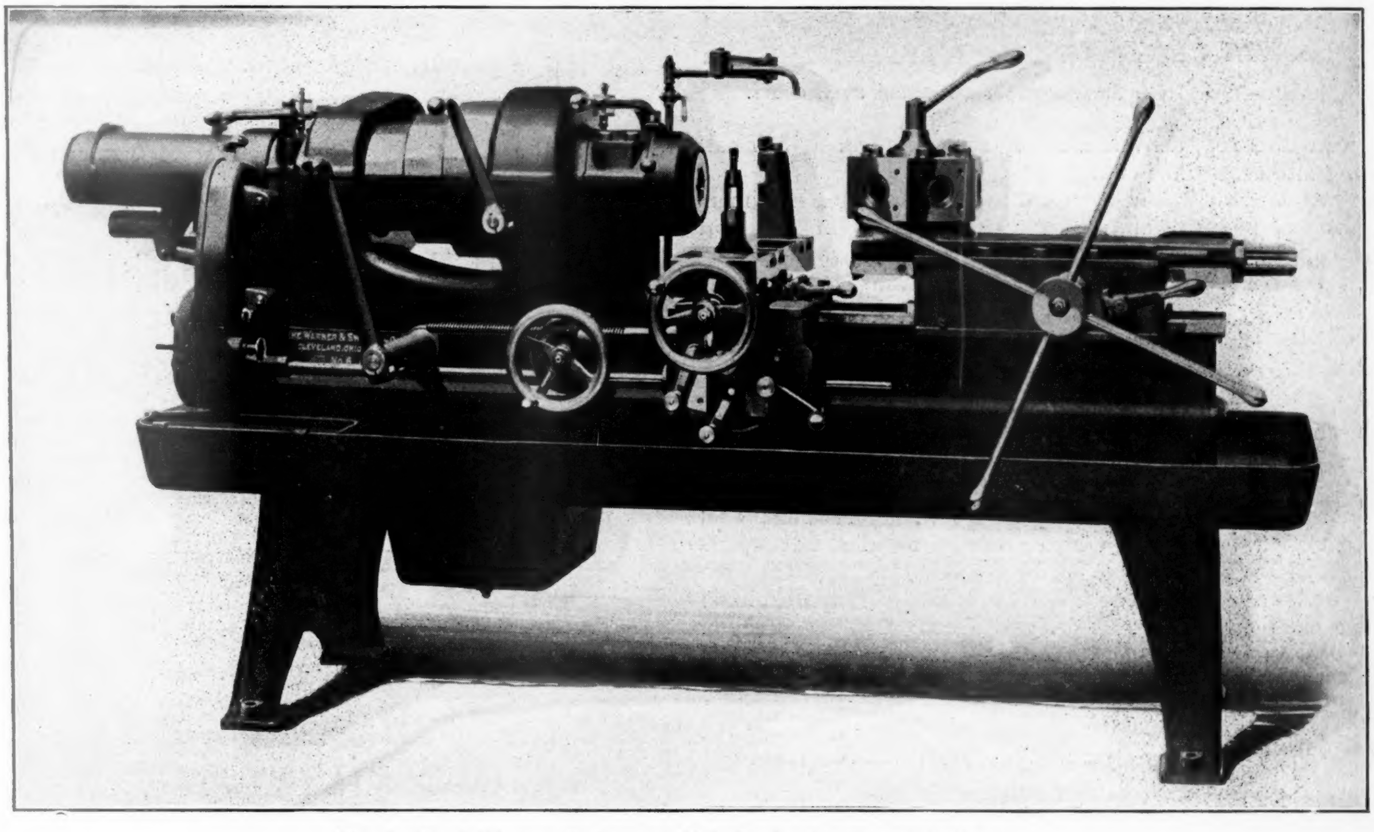


Fig. 1—No. 6 Warner & Swasey High Production Turret Lathe.

The hexagon turret is arranged for holding tools with or without shanks. The six tool holes, counterbored for centering plate tools, are fitted with draw bolts and are bored 1¾ in. in diameter, unless ordered otherwise. Bolt holes are provided for securing plate tools to the faces.

The turret is revolved automatically by the backward movement of the slide. The locking bolt is at the front end of the slide and works into steel taper bushings inserted in the bottom of the turret close to its outside edge directly under the cutting tool.

Independent adjustable stops operate automatically from each position of the turret and disengage the power feeds.

They are readily adjustable for the proper length of each cut.

The turret saddle has a supplementary taper base to adjust the tool holes in the turret to the exact height of the spindle center. Taper gibs, fitted the whole length of the saddle on each side, provide means for adjusting the slide sideways.

Power feed for the turret slide is furnished only when especially ordered, and any one of four feed changes is easily obtainable. The automatic trip operates in connection with independent adjustable stops for each hole in the turret.

An oil pump, which operates when the machine is run in

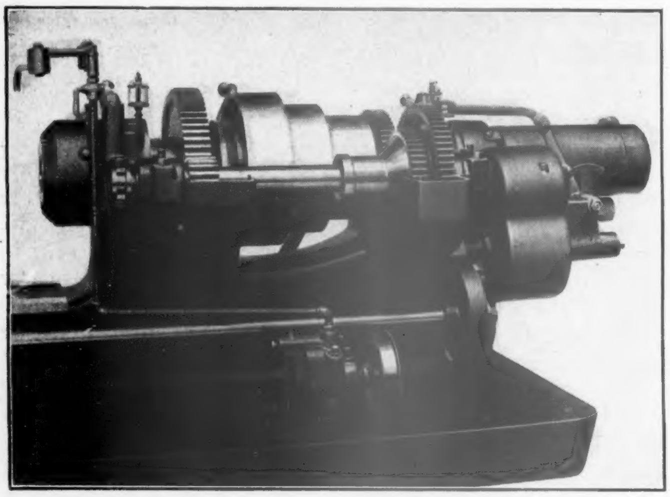


Fig. 2—Rear Head Showing Double Friction Back Gears.

either direction, delivers a steady and abundant flow of cutting lubricant to the cutting tools.

The Warner & Swasey No. 6 turret lathe has a maximum swing of 20⅜ in. and a bar capacity of 2¼ in. On soft machinery steel the threading capacity with a self-opening die head is 1¾ in. The total cross travel of the carriage slide is 10 in. and the total longitudinal travel 14 in. A three-horsepower motor is required to drive this machine.

PRODUCTION FACE GRINDER

After being thoroughly tested over a considerable period of time a new self-contained face grinder, shown in Fig. 1, has been placed on the market by the Cleveland Machine Tool Company, Cleveland, Ohio. The particular advantages claimed for this machine are high production, freedom from breakdown and ease of operation. The L-shaped column is a one-piece box section designed for rigidity and strength. A door in front permits of easy access to the working parts of the machine for oiling, inspection and adjustment. The table is 42 in. long by 9¾ in. wide. One V-shaped and one flat way give ample bearing surface, and because of the fact that the table is larger than the ways the latter are always covered and kept free from dust and grit. The table is provided with a crank handle adjustment, as shown in Fig. 2, by which the arc of oscillation can be readily adjusted to the work to be ground. The throw, or arc of oscillation, can be adjusted up to six inches, which permits of handling work up to 12 in. in diameter. The table is oscillated by a crank disk, driven by a worm and worm gear, insuring a firm and steady motion. Six changes of feed are secured by means of a three-step cone pulley on the machine and a two-speed countershaft.

The grinding wheel head is fitted to a saddle, secured to the main part of the column by a dovetail slide, and gibbed to provide adjustment for wear. The adjusting screw for the saddle is provided with a micrometer dial. The grinding wheel head is pivoted and can be turned to any desired angle, thus permitting the use of wheels of various shapes. The head is graduated in degrees for a space of 30 deg.

The grinding wheel spindle is made extra large, of a special steel, hardened and ground, the bearings being of phosphor bronze. Large grinding wheel flanges are pro-

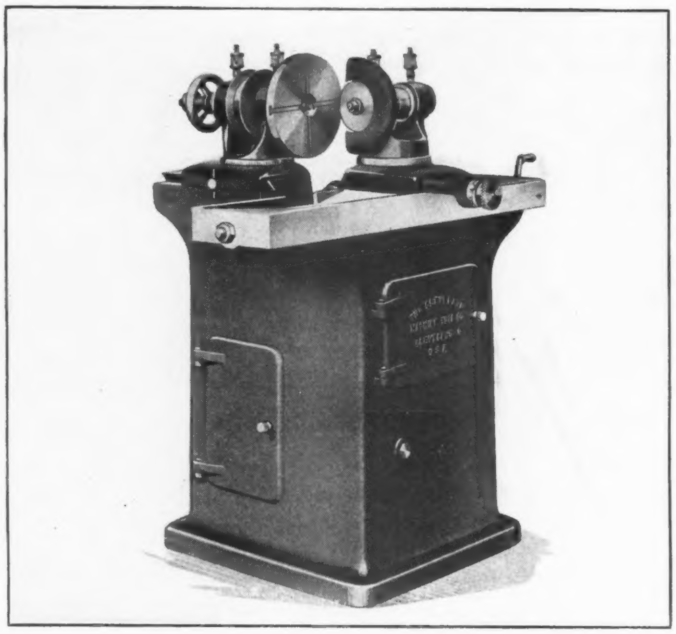


Fig. 1—Cleveland Production Face Grinder.

vided, and a wheel guard large enough to accommodate 8-in. grinding wheels is made a part of the machine.

The work head is secured to the wing of the column by means of a dovetail slide and rests on its own saddle, which has longitudinal adjustment of 6 in. The saddle is attached

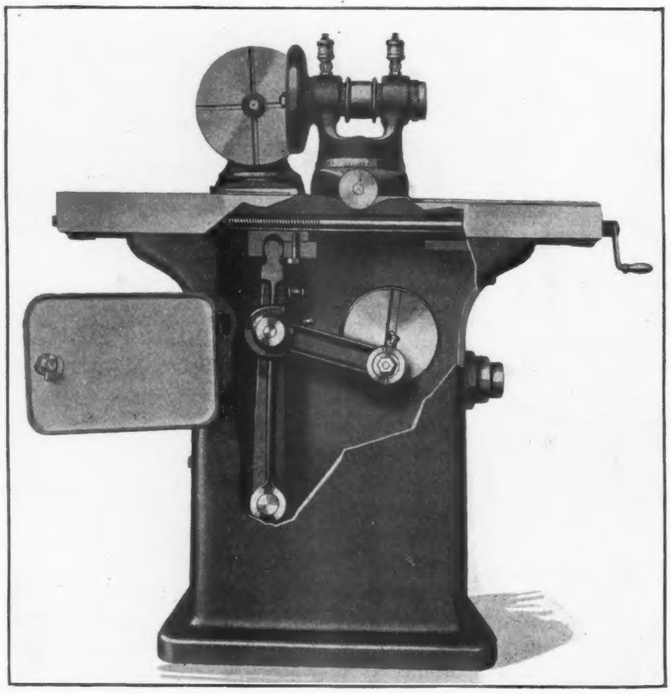


Fig. 2—The Arc of Oscillation Is Easily Adjustable.

to the column by a hand clamping screw, thus providing easy adjustment, and a gib makes this slide adjustable for wear. The machine will accommodate work 6 in. in thickness without overhang of the saddle. By making proper allowance for saddle overhang it is possible to handle work up to

10 or more inches in thickness. The work is pivoted on the saddle and can be swung to any angle.

The work spindle is extra large, made of special steel, hardened and ground, and has a No. 11 Brown & Sharpe taper hole. The spindle bearings are of phosphor bronze, and are adjustable for wear. The nose of the spindle is threaded to receive a 10-in. face plate, which has two 7/16-in. T-slots at right angles, permitting rapid clamping of the work. Careful consideration has been given to lubrication and protection from dust. The four spindle bearings are provided with large sight-feed oil cups, and all cylindrical and flat bearings have oil holes fitted up with dustproof oil caps. The machine is designed especially for grinding metal slitting saws, hubs of milling cutters, faces of bushings, arbor collars, etc.

HEAVY QUICK CHANGE LATHE

A powerful cone type lathe has been placed on the market recently by the Cincinnati Lathe & Tool Company, Cincinnati, Ohio. The lathe is made in four sizes, varying from 22 in. to 28 in. in capacity, and is designed especially with the idea of utilizing the best grade of high-speed steel tools

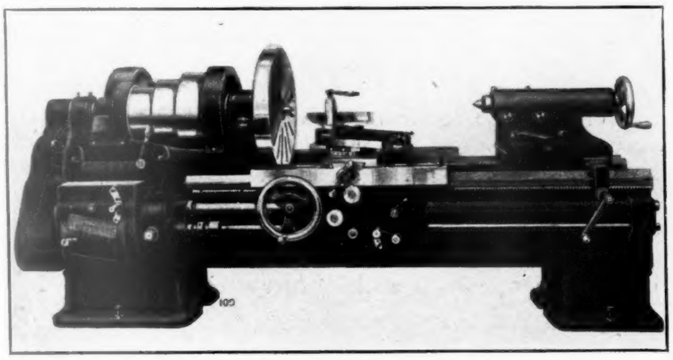


Fig. 1—Cincinnati Heavy Duty Lathe.

to their utmost capacity. The attempt has been made to design a lathe powerful in every detail and without intricate mechanism which may be easily broken or worn out.

The lathe bed, as shown in Fig. 1, is exceptionally heavy

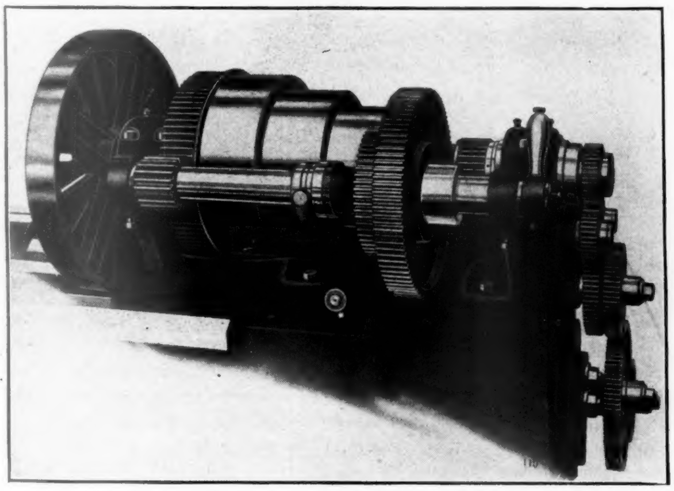


Fig. 2—Rear View of Sliding Double Back Gears.

and, being braced with box section girths, is well able to withstand all twisting strains. The carriage is especially designed to withstand all strains due to heavy cuts, and exceptionally long bearing on the ways is provided. This insures greater accuracy in the cuts taken and also reduces the wear. The apron, of box type construction, is provided with a chasing dial and automatic stop.

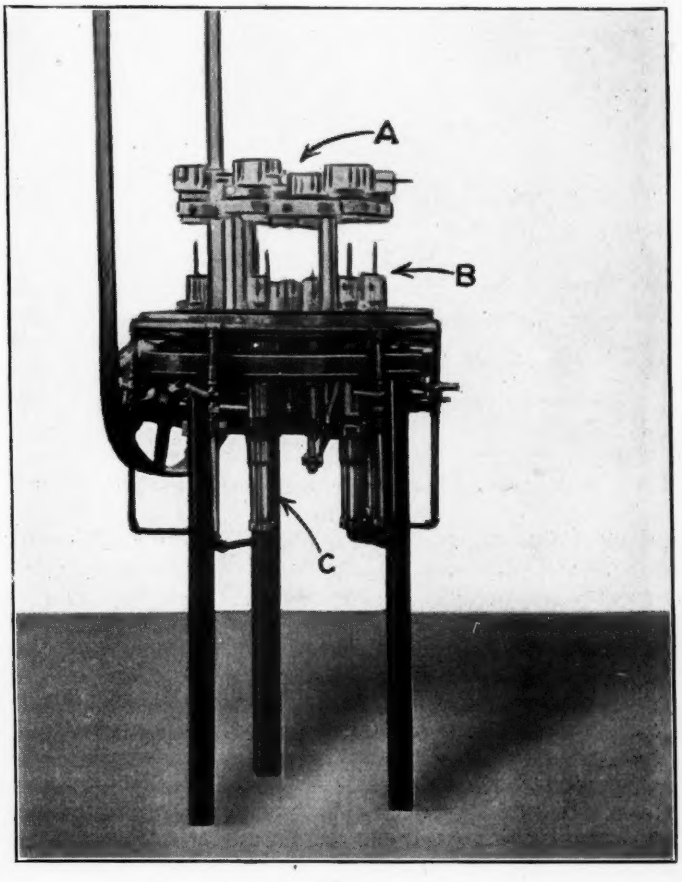
Ample power to drive this lathe is secured by means of the three-cone pulley, which is driven by a 5½-in. belt. The power is transmitted through the sliding double back gear shown in Fig. 2. An idea of the proportions of the headstock may be obtained from the bearings. The front bearing is 4½ in. by 7¾ in., the back bearing 3⅜ in. by 5⅜ in. The quick change gear box of standard Cincinnati construction gives a wide range of speeds and feeds.

The tailstock is equipped with a crank operated pinion, which meshes with the rack and insures easy movement of the tailstock. The two spindle locking devices for clamping the spindle hold it in rigid alinement and obviate the possibility of springing under heavy cuts.

If desired, this lathe can be furnished with turrets on the carriage or the bed, oil pan and pump, taper, relieving or draw-in attachments and turret tool posts. Either cone type or geared head for belt or motor drive may be specified.

STAYBOLT DRILLING MACHINE

Considerable difficulty has been experienced in drilling stay-bolt telltale holes, even before the bolts were applied to the boiler, due to drill breakage, and a five-spindle drilling machine has been especially designed with a view to obviating this difficulty. As shown in the illustration, the



Five-spindle Staybolt Drilling Machine.

machine is belt-driven, the driving shaft being geared to five drill spindles *B*, mounted in an equal number of small air cylinders *C*. Five chucks for holding the stay-bolts are supported on a framework, as shown at *A*. The chucks, which are self-centering and take all sizes of staybolts, are provided with a jig for supporting the drills.

By connecting the cylinders through the connecting pipes

and three-way valves to the shop air line, the drills are forced up into the bolts when the three-way operating valve is opened. By drilling upward the chips may fall out easily, which eliminates a large proportion of the drill breakage. When the three-way valve is placed in release position the spindles drop, thus insuring a quick release. The capacity of the machine illustrated is 75 bolts per hour, with telltale holes 1½ in. deep, or 25 bolts per hour with telltale holes 8 in. deep. This machine is the invention of J. B. Hasty, San Bernardino, Cal., to whom a patent covering the principal features has been issued.

COMBINATION PUNCHING AND SHEARING MACHINE

During the past few years the general tendency in machine tool design has been to combine as many operations as possible in one machine and sometimes to combine the machines themselves. The result of this policy has been to reduce the cost of the machines, cut down the floor space occupied and render the operation of the machine more economical by the elimination of lost motion.

This principle of consolidating machines has been embodied by Joseph T. Ryerson & Son, Chicago, Ill., in a new quintuple combination punching and shearing machine. This machine has also been designed with the idea of obtaining maximum power, efficiency and simplicity of operation. Five metal working machines are combined in one unit, as illustrated in Fig. 1. The operations of shearing of plates, round and square bars, coping and notching, section cutting and punching may be performed without changing any of the tools or attachments; therefore no time is lost due to the interchange of attachments for the various operations. Samples of the work that can be performed are shown in Fig. 2.

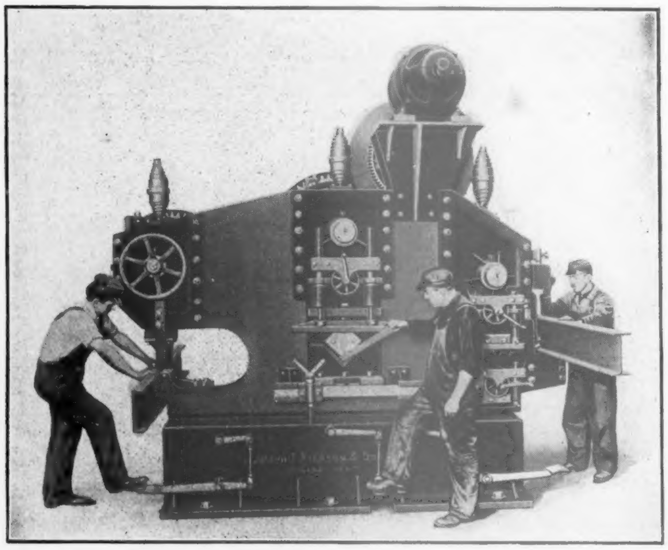


Fig. 1—Ryerson Quintuple Punching and Shearing Machine.

The operating side of the machine is entirely free from all overhanging machine parts, the entire mechanism, such as gears, clutches, fly-wheels, etc., being on the opposite side, as illustrated in Fig. 3. This constitutes a most important safety feature. Ample space is provided in order that the operators will not interfere with one another in handling different kinds of work at the same time. The section cutter especially is given generous space, so that the operator may cut material right or left handed, as desired.

All the foot-lever connections for operating the three clutches are arranged so that they do not interfere with long plates when passing through the full length of the machine frame in the splitting operation. This avoids the necessity for disconnecting clutch rods, as is sometimes necessary. The machines are furnished with heavy ribbed bases on both side to balance them properly and to insure a rigid foundation. The right-hand foot casting is cut away to provide necessary clearance for plates when cut in any length and width.

All machines are equipped with three-jaw automatic clutches for operating the sliding heads independent of each other. The automatic clutch on the front end is provided with a loose disk to permit adjustment of the stroke at any desired position. The clutch for the splitting shear, bar cutter and coping and notching machine can be operated by either hand or foot. The clutches for the punch and section cutter are operated by foot only. All gears except the motor gear are made of cast steel, having teeth from the solid metal. The gears run in extra long bronze bushings and are covered by gear guards, ample provision being made for lubrication. Heavily constructed outboard bearing brackets, illustrated in Fig. 3, take up all the strain when the three tools are operated at the same time.

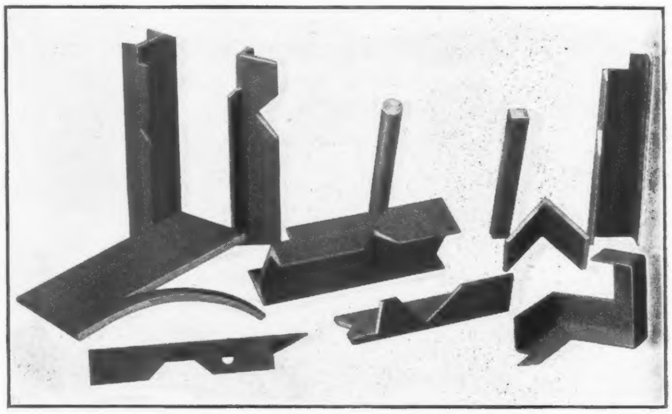


Fig. 2—Samples of Work.

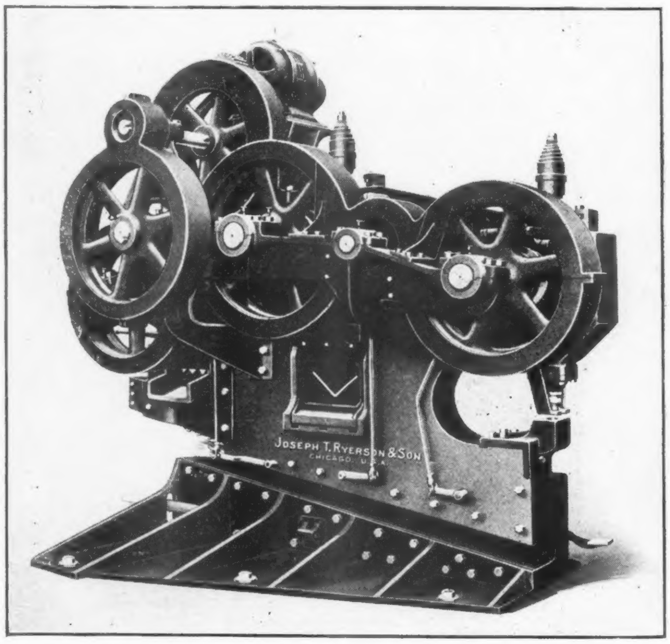


Fig. 3—Back View Showing Arrangement of Overhanging Machine Parts.

The main frame of the machine consists of a skeleton offset shear body, which is reinforced by heavy steel plates,

making the machine extremely rigid and able to withstand severe stresses. The skeleton frame and plates are properly interlocked by means of machine steel pins. The universal plate shear permits of splitting plates up to the maximum capacity in any length and width. An adjustable hold-down for the material is provided.

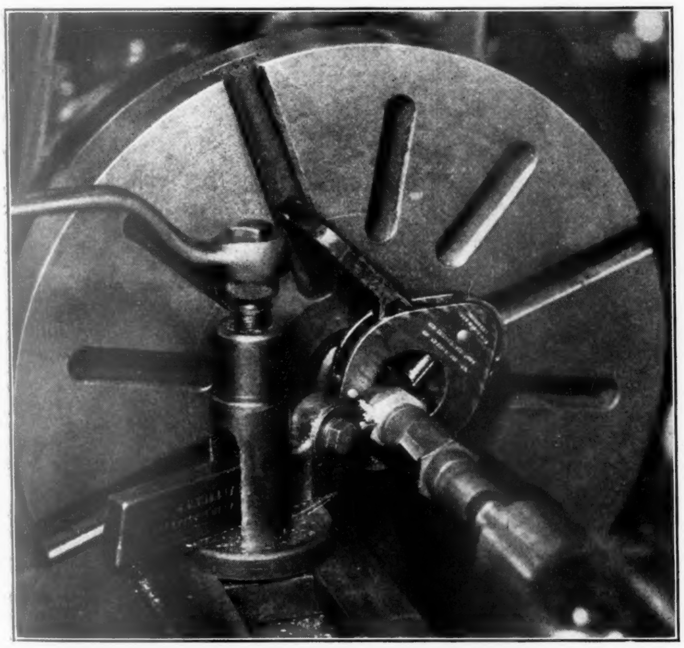
All clutches are equipped with standard architectural jaws, which permit the punching of standard I-beams, channels and sections, both in the flange and the web. Here again adjustable hold-downs are provided, and a cam shaft and hand-wheel arrangement permits the centering of the punch to the full length of the stroke. A shear for cutting round and square bars is provided in the sliding head of the plate shear. Depending upon the capacity of the machine, blades with three or four notches can be provided.

The original design of this quintuple punching and shearing machine provides for direct motor drive, but if desired a belt drive with tight and loose pulley belt shifter can be furnished.

CAM TYPE LATHE DOG

There is more or less danger connected with the use of the common type of lathe dog with its projecting set screw. To obviate this difficulty the Efficiency Device Corporation, Long Island City, N. Y., has devised the lathe dog shown in the illustration, which depends for its action upon the cam principle. It is also claimed that a considerable saving in time is realized, due to the fact that no time is wasted in hunting for wrenches to tighten or loosen the set screw used in the lathe dog of the ordinary type.

A swing of the smooth-jawed cam will open the dog to any size within its capacity and, after the work is inserted, springs actuate the cam and close it automatically. The



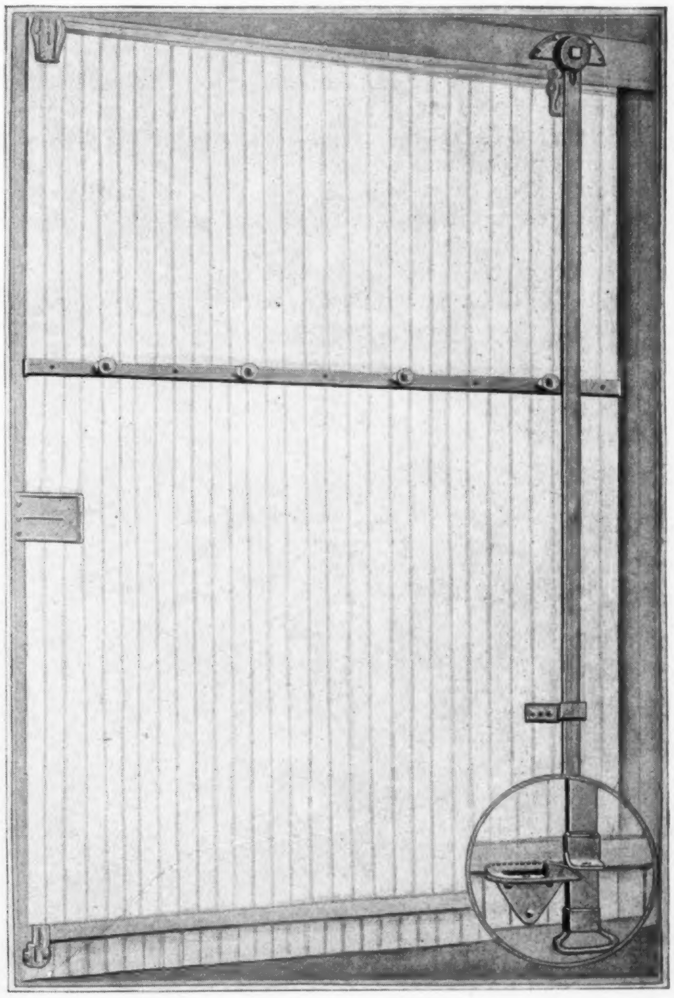
Cam Type Lathe Dog in Operation.

lathe dogs do not depend upon the springs, however, for their driving power, because the harder the pull the tighter the grip. Due to the absence of teeth on the cam, the work is not scored or marked.

This lathe dog is made of a steel drop forging, heavily case-hardened. There are five dogs in a set, with a capacity ranging from ½ in. to 3 in. in diameter, each size having an automatic adjustment of ½ in.

A RADICAL DEPARTURE IN FREIGHT CAR DOOR FIXTURES

ONE of the trying problems which railway employees have to face is that of opening freight car doors without damage to the doors. A new device which is intended to remove this difficulty is the Jerry Loc-Lever. The Loc-Lever works on the leverage principle and when applied takes the place of locks, hasps and starters. The iron bar which forms the lever proper is suspended from the side plate of the car by a bolt and reaches a point a few inches below the lower edge of the car door. Another bar is fastened to the car door and extends across it horizontally about one-third the way from the top. To this are attached four fulcrum pinions formed of bolts inserted through steel tubes, large enough in diameter to revolve around the bolt and thus form a roller bearing. The handle of the main



A Combined Door Lock and Opener

lever is so constructed that the seal or the lock of the car can be inserted through convenient orifices. In operation, when the door is closed the Loc-Lever bar lies against the last pinion and holds the door securely in place. When the door is to be opened the seal is broken, thus releasing the lever, which is then raised away from the car a distance sufficient to pass it over the last pinion, against which it then lies in a diagonal position. A pull is exerted on the handle and from the resulting leverage the door is forced open a short distance. The operation is repeated on the three other pinions in turn, with the result the door is fully opened without damage.

The device takes its name from the nickname of its in-

ventor, H. F. Jerolaman, of the traffic department of the Atchison, Topeka & Santa Fe, who is familiarly known as "Jerry." In his work Mr. Jerolaman noted the difficulties encountered in connection with the opening of car doors and this device is his idea for overcoming the trouble. Besides effecting a considerable saving in the damage ordinarily done the car door, it is anticipated that the device will also save time at stops and transfer points.

INTERCHANGEABLE UNIT SCREW MACHINES

A new line of hand-screw machines, embracing five sizes, to handle work from 7/16 in. to 2-9/16 in., has been designed recently by the Foster Machine Company of Elkhart, Ind. The unit principle of design has been carried out and, as applied to this line of machines, each machine is assembled from a number of separate units built and kept in stock as independent units. For instance, three different styles of cut-off units are available, the lever feed cut-off, hand screw feed cut-off and power feed cut-off. These are interchangeable, one with the other, and can be furnsihed as required. The power feed of the turret is a separate unit, and a machine can therefore be built either with power feed for the turret slide or with hand feed. The automatic chuck and bar feed are independent units and can be furnished or omitted as required.

The No. O and No. 1 screw machines, which are of 7/16-in. and 15/16-in. bar capacity, respectively, are designed for high spindle speeds and the sensitiveness of operation essential in machines of small bar capacity.

The No. 3 screw machine, the bar capacity of which is 1 5/16 in., is built in both the plain head and friction head types. The No. 5 and the No. 7 screw machines, with a bar capacity of 1-13/16 in. and 2-9/16 in., respectively, are built in the friction head type only. The large diameter cone pulley and the powerful friction provide ample power for heavy requirements. The turret slide has an effective travel of 7 in. for the No. 3, 9 in. for the No. 5 and 11 in. for the No. 7 screw machine.

The gear friction head, as shown in Fig. 2, has a powerful friction clutch, mounted on the spindle between the cone pulley and the friction gear, which serves to engage the spindle into driving connection direct with the cone pulley on one side or with the back gears through the large diameter spindle gear on the other side. The frictions are of the cone type and are operated by the hand lever through the medium of a long, movable sleeve and four fingers mounted on the spindle. They are powerful but sensitive in operation.

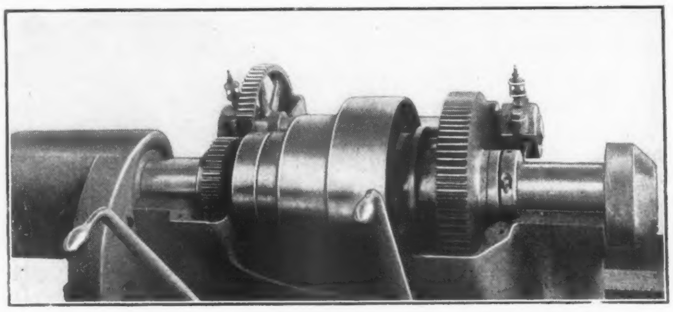


Fig. 2—Arrangement of Friction Head.

The automatic chuck is of a standard spring collet type, and the operating machanism differs materially from previous designs. The fork lever principle has been utilized instead of the sliding fork principle, which eliminates the cocking action and reduces friction. The automatic chuck fingers are equipped with rollers to eliminate friction at this point. It is claimed that with this type of chucks 40 per cent of the force usually applied at the handle of the operating lever will hold the stock.

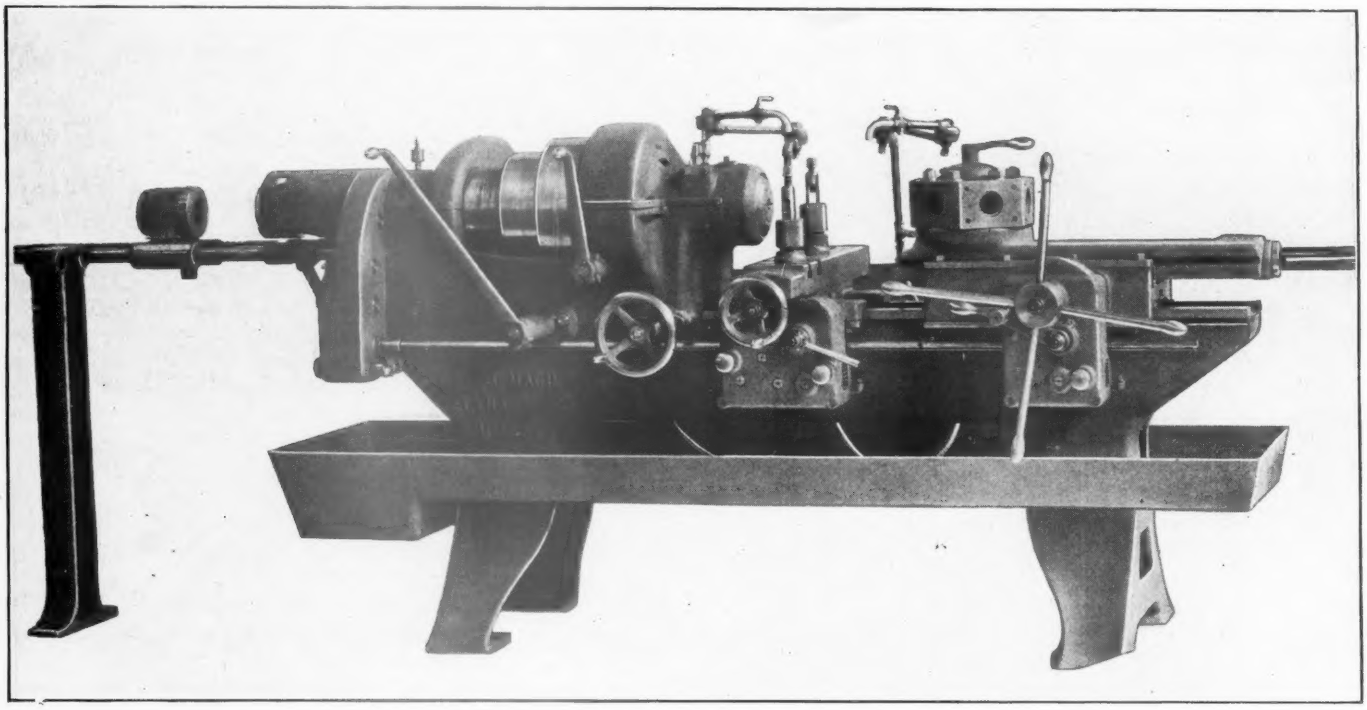


Fig. 1—No. 7 Foster Hand Screw Machine.

The bar feed operating mechanism also is new, in that the continuous motion of the automatic chuck lever as it opens the collet feeds the bar forward. This is accomplished through a system of links and levers in such a manner that the automatic chuck and the bar feed are operated intermittently.

On the heavier screw machines a hexagon turret is used with an indexing mechanism, which is very sensitive in

operation. The vertical lock bolt is mounted underneath the front side of the turret, directly beneath the working tool. The end of the lock bolt lever, which intermittently engages the tumbler for withdrawing the lock bolt preliminary to the indexing of the turret, is equipped with a roller for the sake of sensitiveness and reduction of wear.

A system of revolving independent stops are gibbed to the turret and index with it. The power feed apron for the turret slide is shown in Fig. 3. The three sliding gears, together with a cluster of two sliding gears in the gear box at the end of the machine, provide six different speed changes. The

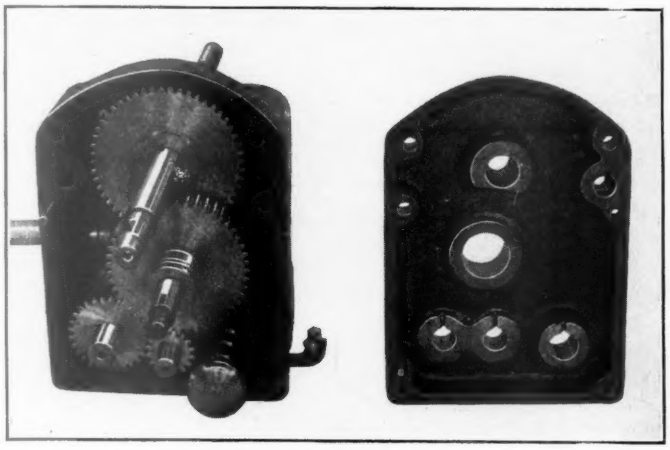


Fig. 3—Power Feed Apron for Turret Slide.

power feed is engaged and disengaged by a friction working in conjunction with the gear engaging the large driving gear of the pinion shaft. The apron is oil-tight, and the lower gears in the gear train, including the worm gear, run in a bath of oil.

The arrangement of gears in the cross feed apron is similar to that in the turret slide, except for the introduction of sliding gears to obtain a reverse of the feed movement. The feed friction, which works in conjunction with the two large intermediate gears, is operated by a ratchet acting as a powerful cam, manipulated by a hand lever. The three-step sliding

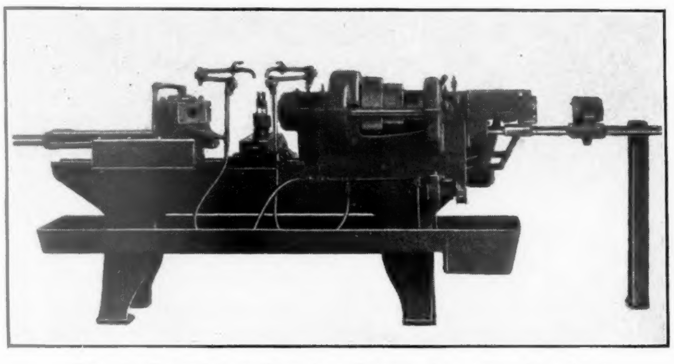


Fig. 4—Rear View Showing Double System of Piping.

gear nests in the apron in conjunction with the two changes obtainable in the gear box at the head of the machine, as described, provide six changes of speed to the cross slide.

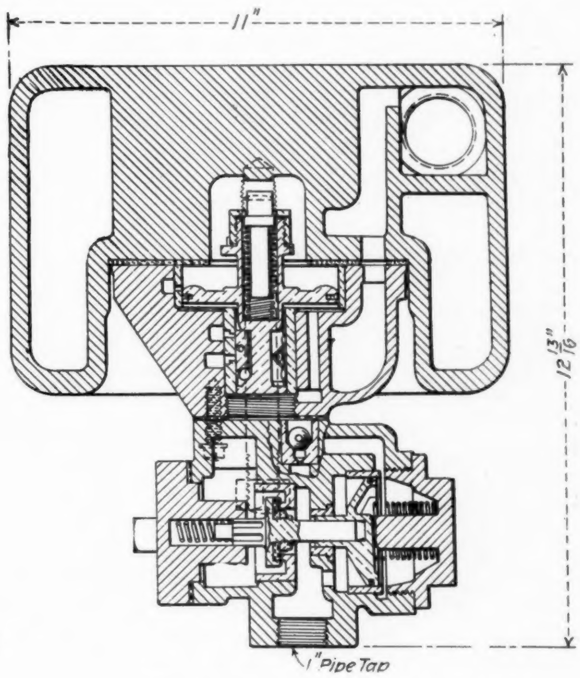
The location of the hand longitudinal feed screw between the ways of the bed is an important feature of this machine. The force moving the cut-off carriage on the bed is applied in the middle of the guards instead of on the front side, where a slight cocking action may result in inaccuracy of adjustment and undue wear of the machine at this point. Large diameter graduated dials, equipped with observation stops, are provided for both the hand longitudinal feed and also for the cross feed.

A double system of piping is provided, as shown in Fig. 4, together with a suitable rotary pump, to furnish the proper amount of coolant to the worm and cutting tools. One system works in conjunction with the turret slide and the other with the cut-off. On the smaller machines, where a smaller amount of coolant is required, only a single system of piping is used.

NO. 4 BRAKE PIPE VENT VALVE

The Westinghouse Air Brake Company, Wilmerding, Pa., has recently developed a brake pipe vent valve to provide a more positive means than has heretofore been available for initiating and propagating quick action throughout a train. Changes in service conditions involving the handling of trains of greater weight and length, with increased brake pipe volume, have made it increasingly difficult to insure the proper quick action throughout the train. This is especially true when double heading, or when the first car or cars in a train are cut out, or when the cars are so coupled together (in cases where the triple valves are installed on the ends) that they are too far apart for quick action to be carried from one to another and throughout the train.

The No. 4 brake pipe vent valve has been designed to



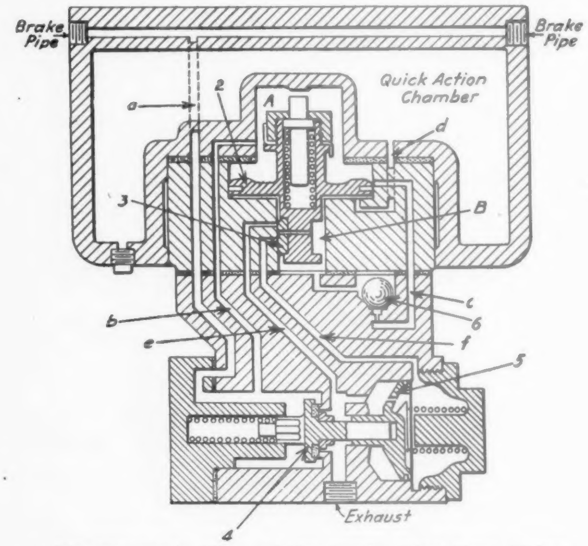
Cross Section of Vent Valve

meet these conditions and, to insure the necessary stability of operation, has been made a separate device to operate independently of the triple valve, distributing valve or other venting devices. Thus the reliability of the vent valve is uniformly insured, at the same time undesired quick action due to erratic action of the service parts of other brake devices or to the overcharging of the brake pipe on the engine and tender is eliminated.

The No. 4 brake pipe vent valve comprises an emergency piston, *2* (Figs. 1 and 2), with its slide valve, *3*, a vent valve *4*, and quick action piston, *5*, and an actuating volume called the quick action chamber. When the system is being charged, brake pipe air flows through passage *a* to the left of vent valve *4*, and thence through passage *b* to chamber *A* above the emergency piston *2*, forcing the piston to its lowest position. This opens charging port *c* in the piston bushing, permitting brake pipe air to flow past ball check valve *6* to the slide valve chamber *B* and thence through passage *d* to

the quick action chamber, charging the latter to brake pipe pressure.

When a service reduction is made in brake pipe pressure, the emergency piston moves upward until stopped by its graduating stem. The charging port is now closed by the piston and the slide valve chamber is connected through the slide valve to the exhaust passage *e*. This permits quick action chamber pressure to reduce in pressure at the same rate as the brake pipe pressure, thus preventing operation of the vent valve during service applications. (When the brakes are released, the quick action chamber is again



Diagrammatic View of the Brake Pipe Vent Valve

charged as above described with the increasing brake pipe pressure.)

When an emergency rate of brake pipe reduction is made, the sudden drop in pressure causes the emergency piston *2* to move upward to its limit of travel, that is, against the cap gasket, opening port *f*. Quick action chamber air in chamber *B* then flows through port *f* to the outer face of quick action piston *5*, and since there is no pressure on the other face of this piston at this time it is moved to the left, opening the vent valve *4*. This makes a direct opening from the brake pipe to the atmosphere through large ports and consequently accomplishes the rapid venting of brake pipe air so necessary for propagating quick action on adjacent vehicles.

A small vent port through the quick action piston allows quick action chamber air to bleed down until the spring operating against vent valve *4* can force both the valves and piston to their normal position, thus closing the outlet to the atmosphere and permitting the brake pipe (and quick action chamber) to be recharged when desired, as above described.

KEROSENE BURNING FURNACE

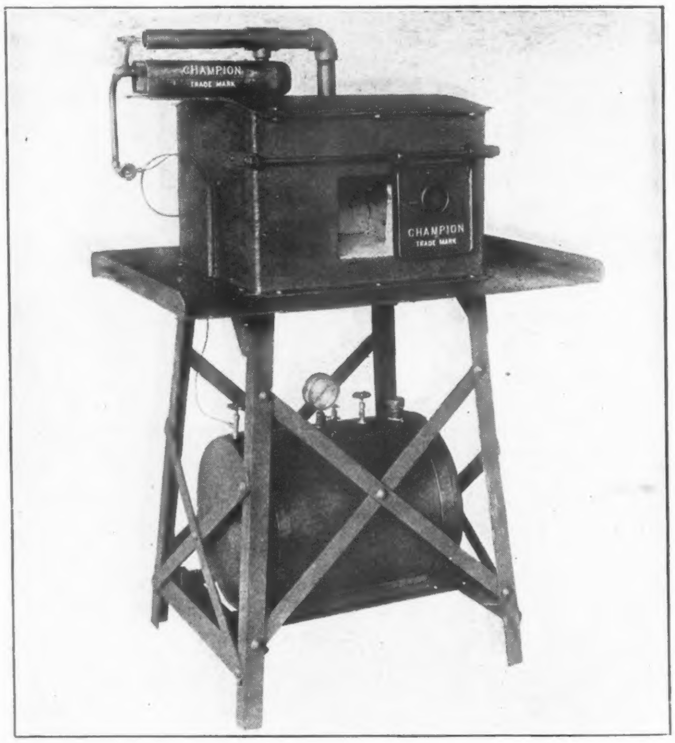
A high-sustained temperature, generated in a short period of time, with strict economy of operation, are features of the furnace illustrated, which is manufactured by the Champion Kerosene-Burner Company, Kenton, Ohio. This heating unit is self-contained and may be used in heating rivets, hardening tools and similar operations.

In operation a quick, intense flame is obtained, as the kerosene is reduced to a gas the moment before being ignited. The effect is the same as that secured by the vaporizing jet in the carburetor of an internal combustion engine. It is claimed that all of the fuel units of the kerosene are utilized and no waste remains to form smoke or unpleasant odors. The flame gives a range of heat of from 2,500 to 3,000 deg. F.

The self-contained feature of the furnace gives it a distinct advantage. The fuel storage tank, carried on the lower platform of the stand, is of sufficient capacity to operate the furnace, with the feed valve wide open, for a 10-hour day. For this reason no electric or pipe connections need be installed in the shop or field. The furnace can be lifted by a crane and moved from place to place without extinguishing the flames. This insures a considerable saving in time both of the operator in changing connections and in cooling and reheating the furnace again.

Compressed air, at a pressure of from 80 to 90 lb., draws the fuel from the storage tank to the burner. This air is forced into the tank by means of an ordinary automobile pump, a pressure gage on the top of the tank showing the air pressure at all times. In spite of the fact that fuel is constantly being drawn out of the tank, with a consequent lowering of the fluid level and enlargement of the air space, the original air pressure still remains adequate to properly feed the burner, and only in exceptional cases does the air supply have to be given extra attention after it has once been taken care of in the morning.

The furnace is economical in the use of fuel. It is claimed that the kerosene consumption, with the furnace operating



Champion Kerosene Burner Furnace.

at its utmost capacity, does not exceed three-quarters of a gallon an hour. In a 10-hour shift the consumption is seven and one-half gallons. At a wholesale price of 14 cents a gallon, the daily cost of fuel would amount to $1.05. The non-oxidizing character of the flame permits leaving the work in the furnace for a long period without danger of burning it or diminishing its size.

If necessary a whole keg of rivets can be dumped into the hearth of this furnace and preheated. Rivets rfo immediate use can be placed directly under the flame of the burner, while the others, already in a semi-heated condition, can be raked in as needed. The Champion Kerosene-Burner furnaces are made in various sizes and provided with one or more burners, depending upon the type of work for which they are intended.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue 12,200 copies were printed; that of these 12,200 copies, 11,124 were mailed to regular paid subscribers, 20 were provided for counter and news company sales, 229 were mailed to advertisers, 29 were mailed to employees and correspondents, and 798 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 119,910, an average of 9,992 copies a month.

THE RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

George Bradshaw, supervisor of safety of the Grand Trunk Western lines and the Pere Marquette, says that the Grand Trunk Western had the fewest casualties per 100 employees during the period of the recent "No accident drive" of any railroad in the United States having the same or a greater number of employees.

Press despatches from Paris, dated November 27, say that on the day preceding the first locomotive on a French railroad to use oil as fuel was sent out on an experimental trip and hauled a heavy train with complete success. It is announced that railroads in France have planned to alter their engines to use oil fuel instead of coal and that 200 locomotives may be thus changed.

Several important Bohemian banks have formed a ten million crown company for the renting of freight cars under the name of Tschechoslovakische Wagonleih-A. G. Negotiations will be taken up with foreign car manufacturers. The cars will be purchased outright and rented only to such industrial undertakings as are stockholders and in proportion to the amount of stock they hold.

Commercial Attache J. E. Philippi, Rio de Janeiro, reports that a commission has been appointed to make a special study looking to the adoption of uniform types of equipment and material for the government railways of Brazil. The members of the commission are to be engineers from the Federal Department of Railway Inspection and the federal railways. The first study will be devoted to the selection of uniform types of locomotives, passenger cars and freight cars for the railroads of one meter gage.

Arrangements for the use of oil as locomotive fuel on the lines of the Missouri, Kansas & Texas in Texas and on some of its Oklahoma lines have been practically concluded and engines are being changed. On the Wichita Falls & Northwestern the work will be completed by January 1. Next, the engines in service in the Smithville district of the Missouri, Kansas & Texas of Texas will be changed, and by the end of the summer of 1920 it is expected that all of the engines on the Texas lines will be equipped to use oil instead of coal. Because of the large expenditure required to equip the locomotives it was necessary to make a long-time contract for fuel in order to protect the additional investment.

The materials clearing house organization of the Pennsylvania Railroad has been transferred from Altoona, Pa., to Philadelphia, in order that the work may be concentrated as far as possible under the supervision of G. W. Snyder, 2d, recently appointed general storekeeper. A number of the clerks were transferred to the Philadelphia office, while a few were retained at Altoona under the jurisdiction of W. F. Vogt, district storekeeper. The remainder have been furloughed until positions can be found for them in other departments.

In order to standardize both equipment and operating practices, the Board of Railway Commissioners for Canada recently ordered that all passenger cars and cabooses hereafter constructed shall be equipped with marker sockets fixed at such elevation as will permit lamps and flags to be placed therein from the platform or floor of the car without the use of steps. Furthermore, according to the order, all passenger cars and cabooses now in use and not equipped with marker sockets in this position must be so equipped on or before May 1, 1920. The action was taken because of the placing of marker sockets at the corners of the roofs in addition to the lower position on some of the passenger cars of the Grand Trunk.

Fuel conservation measures on the Chicago Great Western resulted in such substantial savings during the early months of 1919 that W. L. Park, federal manager, has addressed a letter of commendation to all enginemen as well as others who contributed less directly in securing such a satisfactory record. A comparison of the fuel performance for January, February and March, 1919, with the same months of the previous year, showed a decrease in coal per 1,000 gross ton-miles in freight service equal to 10.7 lb., or 4.1 per cent., equivalent to a monetary saving of $13,956. In passenger service, based on pounds of coal per passenger train car-mile, there was a decrease of 3.1 lb. or 12.9 per cent, amounting in money to $23,650, or a total saving in freight and passenger service of $37,606 for the three months.

J. H. Thomas, the general secretary of the National Union of Railwaymen, who has been conducting negotiations with the British Government relating to railwaymen's wages, in a speech before railwaymen at Bristol on November 16, outlined the government's offer to the railwaymen regarding their participation in government control of the railways. In

brief, the plan is that three union representatives will join the Railway Executive Committee with powers equal to those of the general managers on this committe; a joint board is to be formed composed of five general managers and five representatives of the unions to deal with conditions of service; a committee of 12 is to be formed composed of four representatives from the unions, four from the railway companies and four from the public, with an independent chairman, which will consider questions on which the joint board fails to agree, and, further, local committees will be formed made up of an equal number of representatives from the management and the men to deal with local grievances.

Railroad Reserve Force Proposed

A bill introduced by Senator Thomas of Colorado just before the Senate adjourned on November 19 provides for the creation of a railroad army reserve force of 200,000 men to be trained at land grant agricultural colleges for service on the railroads in times of emergency. Men between 18 and 30 years of age will be eligible for enlistment, but not for re-enlistment. The term of enlistment would be for 10 years, with a provision for 12 months' training for work as train operatives, hostlers or telegraph operators, and during the training period the men would receive regular army pay. If in time of emergency they were put to work on railroads they would receive the usual railroad pay, but would be barred from having any connection with a labor union.

Electrification in Foreign Countries

Electrification of railway lines is constantly receiving more attention and reports indicate that it is being given serious consideration in Sweden, France, Belgium, England, Italy, Switzerland, Australia, Brazil, Chile and Jamaica. In most of these countries electrification is particularly desirable on account of the increased cost of coal and because of the fact that there are in certain sections large water supplies which can very easily be used for the operation of hydro-electric plants.

A committee of French railway engineers has given the electrification situation in America a careful study. A special committee appointed to draw up a program for the electrification of the principal railroads has been able to gather together much valuable data concerning the use of hydroelectricity. Its program proposes the electrification of 5,220 miles of lines of three of the principal railroads, the Paris-Orleans, the Paris, Lyons & Mediterranean and the Midi. In determining upon lines to be electrified, the Midi and the Paris-Orleans considered the relation of the cost of electric power as compared with the cost of power with steam locomotives, and the comparison showed that mountain lines with sufficient traffic should be among the first to be electrified. They also considered the location of the source of hydro-electric energy in relation to the lines, and the importance of this power to other industries. On the Paris, Lyons & Mediterranean, however, the possibility has been considered of using electricity on lines of low grade where there is a heavy traffic, even before putting it on mountain lines where the traffic of these lines is very small. The probable cost, based on prices before the war, is estimated to be $335,000,000. With the traffic of 1913, electrification would save 1,500,000 metric tons of coal, and in the near future the economy should not be less than 3,000,000 metric tons.

Electrification of Belgian railways has been decreed by the Minister of Railways, following a favorable report on such a project made by a committee appointed to investigate such a course. The first line to be electrified will be that from Brussels to Luxemburg, and later the Brussels-Ostend Railway. It is planned to begin the reconstruction work early in 1920.

In Jamaica the government is reported as arranging to have a survey made of the water power of the large rivers to see if electrification of the railways is feasible. The heavy cost of coal and the necessity of a considerable railroad extension owing to an expected agricultural development explain the proposed change. The local agent of the Westinghouse Company, of New York, is collecting data on which the Westinghouse Company might tender plans for laying down the electric railroads.

In Brazil plans have been made for the electrification of the suburban lines of the road and the trunk line from Barra to Pirahy, as well as general plans for the suburban service and the closing of the roadbed from the main station to Deodoro, writes Commercial Attache J. E. Philippi, Rio de Janeiro. The approximate cost of the rolling stock, substations, aerial lines, etc., is estimated at $4,307,377. This does not include the cost of car sheds at the main station and at Deodoro.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railroad Association, Section III.—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Car Foremen's Association of Chicago.—Aaron Kline, 841 Lawlor Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Chief Interchange Car Inspectors' and Car Foremen's Association.—H. J. Smith, D. L. & W., Scranton, Pa.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio.

International Railway Fuel Association.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 25-28, Curtis Hotel, Minneapolis, Minn.

Master Car and Locomotive Painters' Association of U. S. and Canada. A. P. Dane, B. & M., Reading, Mass.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Railway Storekeepers' Association.—J. P. Murphy, Box C, Collinwood, Ohio.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Dec. 9, 1919	The House That Jack Built (Moving Picture): first aid demonstration by E. E. Stevens		W. A. Booth	131 Charron Street, Montreal, Que.
Central	Jan. 9, 1920			H. D. Vought	95 Liberty Street, New York.
Cincinnati				H. Boutet	101 Carew Building, Cincinnati, O
New England	Dec. 9, 1919	Operation of Railroad Terminals, New York Terminal District	J. J. Mantell	W. E. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Dec. 19, 1919	The Industrial Conflict	William L. Chenery	H. D. Vought	95 Liberty Street, New York.
Pittsburgh	Dec. 26, 1919			J. D. Conway	515 Grandview Avenue, Pittsburgh, Pa.
St. Louis	Dec. 19, 1919	The Cummins Bill	Ex-Senator X. P. Wilfrey	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Dec. 15, 1919	Increasing Necessity for Steam Railway Electrification	N. W. Storer	J. M. Byrne	916 West 78th Street, Chicago.

PERSONAL MENTION

GENERAL

J. V. B. DUER, assistant engineer of the Pennsylvania at Altoona, has been made electrical engineer of the new electrical engineering department operated in conjunction with the mechanical engineering department at Altoona.

HENRY GARDNER, supervisor material conservation of the Baltimore & Ohio, with headquarters at Baltimore, Md., has been appointed corporate mechanical engineer, succeeding Morgan K. Barnum, whose death was noted in the November issue. Mr. Gardner was born in Salem, Mass., in 1872 and graduated from the Massachusetts Institute of Technology in 1896. Immediately after graduation he began railroad work as a special apprentice in the Boston & Maine shops at Boston, Mass., at which work he remained until 1900, when he was appointed shop draftsman and inspector at Concord, N. H. During 1904 and part of 1905 he was assistant master mechanic at Concord; between 1905 and 1911 he was respectively erecting shop foreman for the American Locomotive Company at Allegheny, Pa., locomotive designer for the H. K. Porter Company, Pittsburgh, Pa., assistant superintendent of apprentices of the New York Central at New York City; and from 1911 to 1914 was superintendent of apprentices and shop systems. In 1914 he went to the Baltimore & Ohio as assistant superintendent of shops at Baltimore, and the following year was appointed special engineer in the office of the vice-president, also at Baltimore, an office he held until 1917, when he was chosen for the position of supervisor of material conservation, which he filled until the time of his recent appointment, of which mention is made above.

H. Gardner

A. B. CORBETT, whose appointment as assistant mechanical superintendent of the Missouri, Kansas & Texas, with headquarters at Denison, Tex., was announced in the November issue, was born in 1874 at Hannibal, Mo., and received his education in the public schools of Denison, Tex. His entire railroad service has been with the Missouri, Kansas & Texas, he having entered the employ of this road in June, 1888, as a machinist apprentice. After completing his apprenticeship he worked as a machinist until February 1, 1908, when he was appointed night roundhouse foreman at Denison, later being made day roundhouse foreman. On December 1, 1915, he was transferred to Smithville, Tex., as general foreman. On March 1, 1916, he was appointed shop superintendent at Denison and on April 1, 1917, was transferred to Parsons, Kans., in the same capacity, remaining there until September 15, 1919, when he received his appointment as assistant mechanical superintendent.

G. H. HASELTON, general locomotive inspector of the New York Central Lines East, with office in New York, has been retired after 53 years of service in the motive power department, having been general locomotive inspector for the past 12 years.

C. H. HOLDREDGE, road foreman of engines of the Southern Pacific, with headquarters at San Francisco, Cal., has been appointed assistant general air brake inspector succeeding A. M. Meston, promoted.

HARRY A. HOKE, acting assistant mechanical engineer of the Pennsylvania at Altoona, Pa., has been appointed assistant mechanical engineer, succeeding W. F. Kiesel, Jr. Mr. Hoke was born on October 13, 1873, at Union City, Ind. He was graduated from Purdue University in 1896, and on March 1, 1898, entered the employ of the Lake Shore & Michigan Southern as a draftsman at Cleveland. Since December, 1898, however, he has been with the Pennsylvania Railroad at Altoona, being promoted to the position of assistant chief draftsman on September 1, 1902, and to assistant engineer of the mechanical engineering department on June 1, 1906. On February 1, 1919, he was appointed acting assistant mechanical engineer, and on October 20, 1919, was made assistant mechanical engineer.

J. S. JENNINGS, division master mechanic on the Michigan Central at Bay City, Mich., has been promoted to assistant superintendent of motive power, with headquarters at Detroit, Mich., a newly created position.

W. F. KIESEL, JR., who was appointed acting mechanical engineer of the Pennsylvania at Altoona, Pa., on the retirement of A. S. Vogt, has been appointed mechanical engineer. A photograph and sketch of Mr. Kiesel's career were published in the March, 1919, issue, page 165.

B. J. PEASLEY, master mechanic of the Vicksburg, Shreveport & Pacific, has been appointed superintendent of motive power of that road and of the Alabama & Vicksburg and the Louisiana & Mississippi Transfer, at Monroe, La. Mr. Peasley was born on December 21, 1867, at Decorra, Ill., and entered railway service at the age of 16 as a laborer and machinist apprentice with the Chicago, Burlington & Quincy, at West Burlington, Iowa. After serving his apprenticeship he entered a business college at Burlington, Iowa, and on completion of the course again entered railway service as a machinist with the Atchison, Topeka & Santa Fe, at Ft. Madison, Iowa. From 1894 to 1901 he was employed respectively by the Ft. Madison Gas & Gasoline Engine Company, by the Chicago, Ft. Madison & Des Moines, as fireman and engineman, and by the Illinois Central at East St. Louis, Ill., as a machinist and later division and wrecking foreman at Carbondale, Ill. In 1901 he entered the service of the Denver & Rio Grande as roundhouse foreman at Helper, Utah, where he remained a short time, returning to the Illinois Central at East St. Louis, Ill., acting successively as roundhouse foreman, shop foreman and general foreman until September, 1906. At that time he was appointed general foreman of the Missouri Pacific at Bixby, Ill., later being promoted to master mechanic at Ferriday, La., where he remained for six months, being then transferred to De Soto, Mo., as master mechanic of the Missouri division. From February, 1914, to the early part

B. J. Peasley

of 1918 he was superintendent of shops at Argenta, Ark., when he was appointed mechanical superintendent of the St. Louis-Southwestern of Texas, with office at Tyler, Tex. During the early part of the present year he accepted the position of master mechanic of the Vicksburg, Shreveport & Pacific, which he held until his recent promotion.

F. A. McArthur has been appointed mechanical valuation engineer in charge of the valuation of rolling stock of the St. Louis-San Francisco.

Major C. E. Lester has been discharged from military service and appointed assistant supervisor of equipment with the Railroad Administration at Meadville, Pa.

D. M. Pearsall, shop superintendent of the Atlantic Coast Line at Waycross, Ga., has been appointed superintendent of motive power, second and third divisions, with the same headquarters.

S. A. Schickedanz, chief draftsman of the Chicago & Eastern Illinois at Chicago, has been promoted to mechanical engineer at Danville, Ill., succeeding W. H. Hauser, who has resigned to become connected with the A. B. C. Transit Refrigeration Company, Chicago.

R. Tawse, master mechanic of the Detroit, Toledo & Ironton, at Jackson, Ohio, has been promoted to superintendent of motive power and equipment, with the same headquarters.

E. W. Smith, superintendent motive power of the Pennsylvania Railroad, Central division, at Williamsport, Pa., has been transferred to Altoona, Pa., as acting superintendent motive power, relieving R. K. Reading, granted leave of absence because of illness.

S. M. Viele has been appointed assistant electrical engineer of the new electrical engineering department of the Pennsylvania at Altoona.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

William H. Menner, road foreman of engines of the Erie, with headquarters at Jersey City, N. J., has been appointed supervisor of locomotive operation, succeeding E. Salley, deceased.

G. T. Bourne, traveling engineer and trainmaster of the Salt Lake division of the Denver & Rio Grande, with headquarters at Soldier Summit, Utah, has been transferred to the Green River division, with the same headquarters.

Lon Byers, terminal engine inspector on the Atchison, Topeka & Santa Fe Coast Lines at Needles, Cal., has been promoted to road foreman of engines of the first district of the Arizona division, with the same headquarters, succeeding L. H. Ledger.

A. L. Crew, road foreman on the Atchison, Topeka & Santa Fe Coast Lines, with headquarters at Los Angeles, Cal., has been promoted to general road foreman of engines, with the same headquarters, a newly created position.

Andrew J. Devlin, supervisor of shops of the St. Louis-San Francisco, has been appointed master mechanic of the Western division, with headquarters at Enid, Okla. Mr. Devlin was born on June 20, 1868, at Philadelphia, Pa., and was educated in the public schools and Quaker private school. His railroad service dates from August 1, 1904, when he entered the employ of the Atchison, Topeka & Santa Fe as assistant machine foreman. On June 8, 1906, he became shop demonstrator, and on March 1, 1910, supervisor of efficiency work. Since March, 1914, he has been with the St. Louis-San Francisco, first as traveling roundhouse foreman, later as inspector of shop efficiency and then as supervisor of shops, which latter position he held at the time he was appointed master mechanic of the Western division.

Guy F. Egbers has resigned from service with the Russian Railway Service Corps and returned to the Northern Pacific as master mechanic, Pasco division, at Pasco, Wash.

L. H. Ledger, road foreman of engines of the first district, Arizona division, of the Atchison, Topeka & Santa Fe Coast Lines, at Needles, Cal., has been transferred to the second district, with the same headquarters, succeeding C. C. Reynolds.

G. M. Lillis, locomotive engineman of the Denver & Rio Grande, has been appointed traveling engineer and trainmaster of the Salt Lake division, with headquarters at Soldier Summit, Utah, succeeding G. T. Bourne.

William D. Johnston, whose appointment as general master mechanic of the Northwest territory of the Baltimore & Ohio Western Lines, with office at Cleveland, Ohio, was announced in the November issue, was born in Ohio on November 12, 1869. After graduating from the Nickerson (Kansas) high school he took employment as a machinist apprentice with the Atchison, Topeka & Santa Fe. Later he was roundhouse foreman of the Cotton Belt at Pine Bluff, Ark., then general foreman of the Trinity & Brazos Valley at Teague, Texas. Afterwards for different periods of time he was with the Oregon Short Line as general roundhouse foreman at Pocatello, Idaho, general foreman of the Chicago, Rock Island & Pacific, and master mechanic of the International and Great Northern at Palestine, Texas. On May 15, 1914, he entered the service of the Baltimore & Ohio as master mechanic of the Toledo division, was transferred to the Newark division on December 1, 1917, and was appointed general master mechanic of the Northwest territory on August 1, 1919.

W. D. Johnston

J. C. Love, road foreman of engines of the first and second districts of the Los Angeles division of the Atchison, Topeka & Santa Fe Coast Lines, with headquarters at San Bernardino, Cal., has been transferred to the third and fourth districts, with headquarters at Los Angeles, Cal.

F. P. Miller, master mechanic on the Chicago, Milwaukee & St. Paul, with headquarters at Marion, Iowa, has been transferred to Portage, Wis., succeeding M. F. Smith.

C. C. Reynolds, road foreman on the Atchison, Topeka & Santa Fe Coast Lines, at Needles, Cal., has been transferred to the first and second districts of the Los Angeles division, with headquarters at San Bernardino, Cal., succeeding J. C. Love.

M. F. Smith, master mechanic on the Chicago, Milwaukee & St. Paul, with headquarters at Portage, Wis., has been transferred to Minneapolis, Minn.

C. E. Trotter has been appointed master mechanic of the Lake Erie & Western, the Fort Wayne, Cincinnati & Louisville and the Northern Ohio, at Lima, Ohio.

Christian A. Worth, acting master mechanic on the Pasco division of the Northern Pacific, has resumed his

former position as road foreman of engines of the Pasco division.

CAR DEPARTMENT

H. G. Griffin, manager of the National Bridge Company, Montreal, Quebec, has resigned to become general superintendent of the car department of Morris & Co., Chicago.

Samuel Lenzner, master car builder of the Michigan Central with headquarters at Detroit, Mich., has been appointed supervisor of passenger equipment, a newly created position. Mr. Lenzner was born June 30, 1861, at Lancaster, N. Y., and has been with the Michigan Central since July 12, 1886, when he began railway work as a coach carpenter. In September, 1889, he was made foreman of the cabinet department, and in March, 1909, was advanced to general foreman of the car department, which position he held until early in 1913, when he was appointed master car builder.

C. J. Wymer, sales representative of the Grip Nut Company of Chicago, has been appointed superintendent of the car department of the Chicago & Eastern Illinois, with headquarters at Danville, Ill. Mr. Wymer entered railroad service in 1891 with the Atchison, Topeka & Santa Fe. He later became connected with the car inspecting department of the Chicago & Eastern Illinois, resigning as general car inspector in 1912. He was then appointed general car foreman on the Belt Railroad of Chicago. In May, 1916, he was appointed sales representative at the Chicago office of the Grip Nut Company, in which capacity he served until his recent appointment. Mr. Wymer's appointment places him in entire charge of the car department of the Chicago & Eastern Illinois and is the first appointment of this nature made by that road.

SHOP AND ENGINEHOUSE

T. J. Mullin, general foreman, shops of the Lake Erie & Western at Lima, Ohio, has been appointed shop superintendent of that road, as well as of the Fort Wayne, Cincinnati & Louisville and the Northern Ohio, with the same headquarters.

PURCHASING AND STOREKEEPING

Clifford C. Harrold, storekeeper on the West Virginia general division of the Chesapeake & Ohio, with offices at Huntington, W. Va., has resigned that position to become assistant manager for the Tri-State Credit and Adjustment Bureau, Huntington, W. Va.

F. E. Outerbridge has been appointed storekeeper of the Detroit & Toledo Shore Line, with headquarters at Lang, Ohio.

J. M. Strong has been appointed division storekeeper of the Schuylkill division, Pennsylvania Eastern Lines, with headquarters in Reading, Pa.

J. V. Bland, storekeeper of the Virginian at Sewalls Point, Va., has been appointed storekeeper at Roanoke, succeeding J. M. Mitchell.

F. H. Fechtig, purchasing agent of the Atlantic Coast Line at Wilmington, N. C., has been appointed purchasing agent of the Georgia and the Charleston & Western Carolina.

J. M. Mitchell, storekeeper of the Virginian at Roanoke, Va., has been transferred to Victoria, Va., succeeding K. A. Fernstrom, assigned to other duties.

W. N. Pollard, division storekeeper of the Southern & Columbia, S. C., has been transferred to South Richmond, Va., succeeding W. F. Lamb, deceased.

J. H. Smith has been appointed division storekeeper of the Southern at Columbia, S. C., succeeding W. N. Pollard.

SUPPLY TRADE NOTES

H. S. Waterman, sales manager for the Hutchins Car Roofing Company, Detroit, Mich., died in that city on December 1, after an illness of 10 days.

The Ralston Steel Car Company, Columbus, Ohio, has opened an office at 20 E. Jackson boulevard, Chicago, in charge of Ford S. Clark, formerly of the Philadelphia office of the company.

F. C. Wallace, of Pittsburgh, Pa., has withdrawn his resignation as president of the Canadian Locomotive Company, Kingston, Ont., and will continue in office. He has been granted a six months' leave of absence.

F. W. Sinram, general manager of the Van Dorn & Dutton Company, gear specialists, of Cleveland, Ohio, has been elected president of the company. Mr. Sinram is also president of the American Gear Manufacturers' Association.

The Sherwin-Williams Company, Cleveland, Ohio, is contemplating the erection of a factory at Kansas City, Mo., to cost $500,000. The first unit will be equipped for the manufacture of paint and will be followed by the construction of a varnish factory.

John Kopf, formerly associated with the Bureau of Air Craft Production, with headquarters at Dayton, Ohio, has been appointed manager of the engineering department of the Duff Manufacturing Company, Pittsburgh, Pa., with office in that city.

John B. Jordan, assistant manager of the railroad sales department of the Crane Company, with headquarters at Chicago, has been appointed manager of the department with the same headquarters, succeeding F. D. Finn, who has been granted an indefinite leave of absence.

John L. Bender has resigned as sales manager of the Anderson Forge & Machine Company, Detroit, Mich., to become connected with the engineering department of the C. A. S. Engineering Company, at Detroit, sales agent of the Pollak Steel Company, Cincinnati, Ohio.

Frank J. Walsh, mechanical expert with the Galena-Signal Oil Company, New York, has resigned to become secretary of the Douglas Wray Paper Company, Chicago. Previous to his service with the Galena-Signal Oil Company, Mr. Walsh was a division master mechanic on the Chesapeake & Ohio.

W. D. Horton, district sales manager of the Patton Paint Company, has resigned to accept a position in the western railway department of the Murphy Varnish Company, with headquarters at Chicago. Mr. Horton was circulation manager of the *Railway Mechanical Engineer* prior to his connection with the Patton Paint Company.

The International Railway Supply Company, New York, announces that it has incorporated the International Railway Supply Company of Cuba, with Otis R. Hale, former locomotive superintendent of the United Railways of Havana, as manager. The office of the company in Havana is at Edificio Abreu, Room 501, corner Mercaderes y O'Reilly.

A. C. Allshul, in charge of the Milwaukee, Wis., district office of Joseph T. Ryerson & Son, Chicago, has been appointed branch manager of the new warehouse plant at Buffalo, N. Y., this company having recently bought the warehouse plant, stock and good will of the Ferguson Steel & Iron Company, Buffalo. The property covered by the purchase includes a main building of about 100,000 sq. ft., a large crane-served yard, office building, garage and

storehouse. Plans are being made to carry out extensive improvements to the property this coming winter. The Ryerson Company now has plants for warehouse service at Chicago, New York, Detroit, St. Louis and Buffalo.

G. O. Helmstaedter, Chicago district manager of the Hyatt Roller Bearing Company, has been promoted to sales manager of the industrial bearings division with office at New York, succeeding Carl E. Eby, who has been appointed to the board of directors of Hyatt, Ltd., London, a new company formed to market Hyatt bearings in Europe.

The A. Gilbert & Sons Brass Foundry Company, St. Louis, Mo., has recently completed a two-story with basement addition, 25 ft. by 180 ft., to its plant. The basement is to be used for the heating plant, wash rooms and lockers; the first floor for metal storage and melting rooms, and the second floor for the office and wood and metal pattern department.

Joseph T. Ryerson & Son Company, Chicago, has purchased a block of property adjoining its plant in that city, with an area of 380,290 sq. ft. A brick foundry building valued at $100,000, located on the property and at present occupied by the Crane Company, Chicago, will be used by the purchaser as the first unit of an addition to its facilities.

Work is now under way on the Niles, Ohio, plant of the Youngstown Steel Car Company, Hazelton, Ohio. The new plant will be used for repairing cars for railroad companies and private owners. Industrial cars of smaller dimensions than standard rolling stock will be built early in 1920. It is said the complete new plant will be in operation in January, 1920.

K. C. Gardner, assistant manager of sales of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, has been appointed manager of sales for the central district with offices in the Farmers Bank Building, Pittsburgh, Pa. Mr. Gardner entered the employ of the Pressed Steel Car Company in 1901, and was connected with the operating department at McKees Rocks, Pa., until 1911. He was transferred to the New York office, remaining there for a period of eight years, and on January 1, 1919, returned to Pittsburgh as assistant manager of sales, central district, which position he held until his recent promotion to the position of manager of sales of the same district.

K. C. Gardner

C. F. Neudorfer, general plant superintendent for the Standard Tank Car Company, Masury, Ohio, has been promoted to general manager. N. L. Mabey, chief engineer, becomes assistant general manager. J. W. Todd, becomes assistant purchasing agent in the office of the superintendent of transportation, and J. T. O'Connor, superintendent of transportation, has been appointed purchasing agent.

The Keller Pneumatic Tool Company, Chicago, has opened branch offices in Birmingham, Ala., Jefferson County Bank building, under the management of H. I. Kahn; at Salt Lake City, Utah, in the Newhouse building, under the management of the C. H. Jones Company; and in San Francisco, Cal., Los Angeles, Cal., and Portland, Ore., all under the management of the Eccles & Smith Company, San Francisco.

Extensions are contemplated by the Lima Locomotive Works, Lima, Ohio, which will increase the plant's capacity approximately 50 per cent and involve an expenditure of $1,250,000. Additions to the present plant include a new erecting shop with a capacity of 70 locomotives a month, and a superheater shop extension for the boiler and tank works. New machinery costing approximately $300,000 will be purchased.

Huntley H. Gilbert, assistant manager of sales of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, has been appointed manager of sales for the western district, at 425 Peoples Gas building, Chicago, Ill. Mr. Gilbert was graduated from Cornell University in June, 1907, with the degree of mechanical engineer. He then was in the employ of the Illinois Steel Company, the Scully Steel & Iron Company and the George E. Molleson Company, and in June, 1912, entered the employ of the Pressed Steel Car Company, as sales agent in the Chicago office. In 1915 he was sent to England and France as special representative to investigate the manufacture of shell forgings. In July, 1917, he was commissioned captain in the Ordnance Officers Reserve Corps and reported for duty July 25, 1917, as assistant to the chief of the Field Artillery Section, Carriage division, Ordnance Department, serving in Washington until February, 1918, when he was transferred to the Rock Island Arsenal as executive assistant to the commanding officer, later administrative officer, and on July 25, 1918, he was promoted to major. He attended the October, 1918, staff class at the War College, and was then appointed division ordnance officer, 97th Division, Camp Cody, N. M., serving there until the division was demobilized, at which time he was honorably discharged from military service. In January, 1919, he re-entered the service of the Pressed Steel Car Company and Western Steel Car & Foundry Company as assistant manager of sales, western district, and was recently promoted to manager of sales of the same

H. H. Gilbert

H. H. Harris has been appointed manager of the heat treating equipment department of the Quigley Furnace Specialties Company, New York. Mr. Harris was formerly general sales manager for the Swedish Crucible Steel Company and has devoted several years to the practical application of materials for heat treating purposes, especially to steel mixtures and special alloys for carbonizing and annealing boxes, cyanide pots, etc.

A. G. Gibbons has become associated with the Wetmore Reamer Company, Milwaukee, Wis., as production engineer. He was formerly superintendent of tools and supplies for Winslow Brothers Company, Chicago. He also served with the Cadillac Company and the Brown & Sharpe Manufacturing Company for many years. The Wetmore plant has been rearranged and additional equipment installed under the direction of Mr. Gibbons.

The International Steel Tube Company has been incorporated under the laws of Delaware with a capital of $2,500,000, and is planning the immediate construction of the first unit of a seamless tube plant at Cleveland, Ohio. William P. Day, president of the International Steel Tie Company, is president, and Thomas Parrock, former superintendent of the Republic Steel Company, Youngstown, Ohio, is vice-president of the new concern.

Norton Company

Among the changes in personnel of the Norton Company, Worcester, Mass., following the reorganization of that company, were the appointments of Herbert Duckworth as sales manager of the grinding wheel division and of Howard W. Dunbar as sales manager of the grinding machine division. Mr. Duckworth is a native of Worcester county and attended the public schools in Worcester until 1895, when he accepted a position with the Norton Company, then known as the Norton Emery Wheel Company. In 1897 he was appointed head of the order department of that organization, in which capacity he served for about nine years. Subsequently he became a Norton representative in the outside field, covering successively New York state, Pennsylvania and New England. He was promoted to assistant sales manager in February, 1915. This position was held until the reorganization of the company, when Mr. Duckworth was appointed to the position which he now holds of sales manager of the grinding wheel division.

H. Duckworth

The appointment of Howard W. Dunbar as sales manager of the grinding machine division of the Norton Company brings to this position a man with comprehensive experience along general manufacturing and engineering lines. Mr. Dunbar's education in the general high school was supplemented by business and technical courses, and on leaving school he entered the employ of the Stanley Instrument Company, Great Barrington, Mass., as an apprentice on general work in the test division and drafting department. He later served an apprenticeship in tool-making for the same concern. After his experience with the Stanley Instrument Company Mr. Dunbar was employed by the New York Adding Typewriter Company as draftsman and tool designer. Later he was employed by the Ellis Adding Typewriter Company, J. M. Quimby Company, Newark, N. J., and for eight years by the Western Electric Company, New York, in the capacity of draftsman, designing engineer, assistant master mechanic and chief efficiency engineer. In March, 1915, Mr. Dunbar came to the Norton Grinding Company as assistant chief engineer, being engaged in development and engineering work under the direction of Charles H. Norton, designer of the Norton cylindrical grinding machines. Upon the merger of the Norton Grinding Company with the Norton Company Mr. Dunbar was appointed to his present position.

H. W. Dunbar

The T. H. Symington Company

At a meeting of the board of directors of this company, held in New York on October 22, C. J. Symington was elected president in charge of sales and operation, succeeding T. H. Symington, elected chairman of the board, both with headquarters at New York. Donald Symington, vice-president in charge of operation at Rochester, has resigned from the company.

Thomas H. Symington, chairman of the board, was born on May 14, 1869, at Baltimore, Md., and educated at Lehigh University. In 1885 he served as an apprentice at the Mt. Clare shops of the Baltimore & Ohio and subsequently was consecutively journeyman-machinist, inspector of engines and inspector of materials on the same road. From August to November, 1893, he was draftsman at the Richmond Locomotive Works and then for two years was general outside inspector of the same works. From November, 1895, to June, 1898, he was assistant superintendent of the Richmond Locomotive & Machine Works and then to April, 1901, was superintendent of motive power on the Atlantic Coast Line. He then organized and became president of the T. H. Symington Company, with a plant at Corning, N. Y. In 1908 he reorganized the company and built one of the largest malleable iron plants in the country at Rochester. In 1916 he organized the Symington Machine Corporation, Rochester, for handling large shell contracts for Great Britain and Russia. Two years later he extended the operations of the machine company to handle government orders for shells and he organized and operated additional plants, including The Symington Anderson Company, to manufacture 75 mm. French model 1897 field pieces; also organized the Symington Forge Corporation to manufacture 75 mm. shell forgings and the Symington Chicago Corporation to manufacture 155 mm. shell forgings and machine shells. He was appointed assistant chief of ordnance in September, 1918, and since November of the same year, when he resigned his commission from the army, served as president of the T. H. Symington Company, malleable iron foundrymen and manufacturers of railroad equipment, with headquarters at New York.

Charles J. Symington, president, was born on February 2, 1883, at Baltimore, Md., and was educated at Amherst College. He entered the service of the T. H. Symington Company in 1908 as assistant manager, eastern sales, with headquarters at Baltimore, Md. In 1910 he went to Chicago as general sales agent and in 1912 was appointed vice-president in charge of sales, with headquarters in New York. He became president of the Symington Machine Corporation in 1918, with offices in Rochester and Washington; vice-president of the Symington Anderson Company, and vice-president of the Symington Chicago Corporation.

M. J. Keane, manager of the steam goods branch of the Canadian Fairbanks-Morse Company, with headquarters at Toronto, Ont., has resigned and organized the Valve Engineering Company, with office at 160 King street West, Toronto. The new concern will act as agents for the Pennsylvania Flexible Metal Hose Company, the Penberthy Injector Company, Spands & Witwyte, manufacturers of pressure packing for steam and gas engines.

CATALOGUES

BALANCING APPARATUS.—A small pamphlet has been issued by the Vibration Specialty Company, Philadelphia, Pa., describing briefly the service which this company is prepared to render and its balancing apparatus to eliminate vibration in heavy machinery. Several illustrations show rotors and crank shafts which were put in balance on equipment of this company.

VALVE FACING TOOLS, ETC.—An illustrated catalogue and price list of valve facing tools, ball check valves, solid and hollow balls, pneumatic tube welding machines, ball finishing tools for repairing superheater ball joints, pnuematic locomotive turntable motors, etc., products of the Draper Manufacturing Company, Port Huron, Mich., has been issued by this company and is known as Catalogue No. 7.

METALLIC PACKING.—A four-page folder, issued by Harry Vissering & Company, Inc., Chicago, describes and illustrates the construction of Crescent metallic packing for valve stems and piston rods of locomotives. This packing is made of four flexible pieces, all the points overlapping, and is adapted for use with either saturated or superheated steam.

AEROIL THAWING OUTFITS AND TORCHES.—Bulletin No. 10 has recently been issued by the Aeroil Burner Company, Inc., 400 Main street, Union Hill, N. J. This illustrates the Aeroil thawing outfit and shows their application in thawing out hoppers of coal cars. The outfits are designed especially for use in the removal of ice and snow from frozen coal, sand and ore cars, hoppers, pockets, tracks and switches, etc.

DRILL SIZES FOR THREADED HOLES.—The Western Tool & Manufacturing Company, Springfield, Ohio, has issued a card which will be found useful for determining the proper size drill to be used for holes that are to be tapped. It gives the drill sizes for machine and hand taps from 1/4 in. to 2 in. for the various numbers of threads per inch commonly used and also the sizes for pipe taps and machine screws.

PULVERIZED COAL FOR LOCOMOTIVES.—The Fuller Engineering Company, Allentown, Pa., describes its equipment for burning pulverized fuel on locomotives in Bulletin No. 21. Figures are given covering the cost of drying and pulverizing coal and of installing a pulverizing plant. The advantages of this method of firing locomotives are described and sectional drawings show the equipment applied to locomotives.

HIGH SPEED ALLOY STEEL.—An attractive cloth bound book of 92 pages, 4 in. by 6 in., entitled Catalogue and Hints on Steel, is being distributed by the Halcomb Steel Company, Syracuse, N. Y. This catalogue contains a brief description of the company's various grades of crucible and electric tool and alloy steel and their uses, with instructions for treating. It also contains a large number of tables of useful information on areas, weights, etc.

MALLEABLE IRON.—The American Malleable Castings Association, Cleveland, Ohio, has prepared a short treatise on malleable iron, explaining its structure, uses and treatment, and indicating a few of the principles on which the process of making malleable iron castings is based, as well as some of the results that have been attained. The booklet is illustrated with a number of photographs showing results of various kinds of tests to determine the strength of the material.

TANK FRAME LOCOMOTIVES.—In Record No. 94 the Baldwin Locomotive Works describes tank frame locomotives for narrow gage railways. These locomotives have been designed for operation on rough tracks and sharp curves and are particularly suitable for industrial, contractors and other classes of special service. Illustrations of a number of locomotives of this type built by the Baldwin Locomotive Works are contained in the booklet, with tables showing their general dimensions.

WELDING AND CUTTING EQUIPMENT.—The Carbo-Hydrogen Company of America, Pittsburgh, Pa., has issued nine bulletins bound in a folder, describing cutting and welding torches and tips, regulators, and a portable cutting outfit mounted on a truck. All of the parts for carbo apparatus are catalogued in one of the bulletins and another contains directions for operating carbo cutting torches, bringing out some points that should be carefully observed when operating any cutting torch.

HIGH TEMPERATURE CEMENT.—Hytempite, a material for bonding firebrick and kindred uses, which is manufactured by the Quigley Furnace Specialties Company, New York, is described in a pamphlet entitled Hytempite in the Foundry. This material can be used as a binder wherever fire clay, silica brick or tile are used, requiring no heat to effect a bond between materials jointed. A number of applications of Hytempite in foundry work are described, with directions for applying the material.

STANDARD LOCOMOTIVES.—The Locomotive Superheater Company, New York, has compiled and published in Bulletin No. 7, general arrangement drawings and details of construction, together with a photograph and general data for each of the 12 types of standard locomotives designed by the United States Railroad Administration. Wheel loading and clearance diagrams for each are also given, making it a convenient reference book for information pertaining to the standard locomotives.

CHAIN DRIVES.—"A Chain of Evidence" is the title of a 20-page illustrated booklet published by the Morse Chain Company, Ithaca, N. Y., describing the construction of Morse silent chains, a distinguishing feature of which is the "rocker joint," consisting of a rolling or rocking bearing in each joint, which permits a rolling friction in place of the sliding friction common to other types of joints. Among a number of illustrations of large power drives is one showing the largest chain drive in the world—of 5,000 h.p. for hydroelectric purposes.

CUTTERS, ETC.—The Cleveland Milling Machine Company, Cleveland, Ohio, has revised its list of cutters in Catalogue B. This catalogue contains 140 pages, giving standard sizes and prices, and illustrating the line of tools, such as cutters, end mills, collets, hobs, etc., made by this company. Many valuable tables are contained in the catalogue, including tables of cutting speeds, corresponding diametral and circular pitches, decimal and millimeter equivalents, drill size decimal equivalents, screw threads and spur gear tooth spacing and thickness.

SUPERHEATERS.—Two circulars dealing with the maintenance and operation of superheaters are being distributed by the Locomotive Superheater Company, New York. Bulletin No. 6 is entitled "The Most from Superheating" and contains a reprint of the committee report of the Traveling Engineers' Association on superheating locomotive performance. Bulletin No. 8 contains instructions for properly maintaining and operating superheaters. It deals with such matters as lubrication and drifting, flue cleaning, handling units during repairs, etc. Another bulletin, No. 5, describes the company's model "496" pyrometer equipment for locomotive service.